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Ana Simões
Maria Paula Diogo
Kostas Gavroglu *Editors*

Sciences in the Universities of Europe, nineteenth and twentieth Centuries

Academic Landscapes

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Chapter 1
Introduction

Ana Simões, Maria Paula Diogo and Kostas Gavroglu

Since the very last years of the twentieth century, European universities have been undergoing transformations whose overall repercussions are still very difficult to assess. In the three decades after the end of the Second World War, the universities which had been an integral part of the welfare state were, on the whole, adapted to the aspirations of a society imbued with the dominant values of equality in educational opportunities and a non-utilitarian vision of higher-education. Since the mid-1980s new socioeconomic realities forced universities to new adaptations, and the Bologna declaration of 1999 became the symbolic beginning the beginning of a new period for the European universities. The Bologna process has brought about a rather distressful change in the European universities which now make up a more or less homogeneous whole, far removed from the varied and pluralistic institutions they used to be. There are many other aspects of the Bologna process that have been criticized. However, being critical of what the policies of the Bologna declaration brought about does not by any means imply that the situation existing before Bologna had been satisfactory. Surely one cannot assess such a complicated framework through checks and balances, though a serious systematic study of where the universities are heading is wanting.

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1.1 European Universities in the Marketplace

To legitimize the Bologna process, a number of strategies have been articulated: The first thing was to convince citizens in Europe of the dismal state of European universities. We were told, again and again, that the ties of the universities with the industrial sector were highly problematic, that they were doing things not too relevant for society's needs, that research results were not producing innovative products and processes, that students' mobility was undermined by national constraints, and that the really good university teachers did not receive anything more than the miserable salaries received by their less motivated colleagues. So the aim was to create a truly European university system, which would cooperate with industry, contribute to the well being of society, restructure its research in order to continuously innovate, provide students with full mobility and pay more to good teachers. This idyllic situation would be complemented by a free bonus: If European universities would follow these steps, they would eventually overcome the American universities which, we were told again, were so much better than the European. Next to innovation, assessment became the very process via which these aims were achieved: Assessing the quality of teaching, research, teachers, services, and assessing the overall quality of each university became the rule. Who in her right mind would be against such a nearly utopian world? More so, in fact, since the bureaucrats reassured us that this was not a groundless utopia. This was a well thought out path. This was a prospect of dreams come true.

All this was happening within a context of Europeanization of almost all aspects of life in Europe. For many years, Europeanizing everything has been the steady aim of many politicians and public personae. Europeans, we were told, decided to leave behind a past full of intense rivalries, bloody conflicts, national pride(s) and xenophobic attitudes and embrace the ideals of a united Europe. In the last quarter of the twentieth-century, Europe was pictured as more united and determined to overcome its horrific past than ever before. It was the time when Europe had collectively decided that there was much to be gained by realizing grandiose common projects. Though the amazing lack of interest and enthusiasm for this vision has been repeatedly expressed by many citizens of Europe, the Brussels bureaucrats have been insisting on pushing the agenda of Europeanizing everything, showing no sensitivity to what most European citizens had expressed concerning the "European dream."

Fifteen years since these changes accelerated the transformations of the universities in Europe, one thing is becoming clear: The universities in Europe have been fast moving away from the Humboldtian values upon which the very idea of modern university has been based. The challenge is not to re-establish the old order. The future of universities will be shaped not by a stubborn insistence on principles, which have completed their historical role, but by the ways they will deal with a number of new issues that are in the making. In what follows, we discuss some of the new issues universities are facing, and whose almost global characteristics imply that they transcend localities, independent of the fact that there are always specific features and variations due to local constraints.

1.1.1 Bibliocentrism

At least for the last four centuries, universities relied on the printed word conveyed by books and pamphlets which had an absolutely decisive role in the production, communication and, very often, legitimation of new knowledge. The printed word acquired an impressive prestige, becoming almost synonymous with authority, authenticity, reliability, and carrying with it a sense of power and, hence, of credibility. This centrality of the materiality of the printed word seems to be historically coming to an end: The computer and internet are no longer simply technological feats. They have become determinants of new cultural trends, to a large extent defining overall academic practices, and everydayness in teaching and research. And, thus, the naturalization of information technologies shaped new ways of reading and thinking. Correspondence through letter writing commanded a different kind of thinking than e-mails, writing articles on paper and typing them required a totally different mentality on how to express oneself, going to the library to do research and/or meet course requirements and complete term papers demanded a different attitude and sociability than having everything available on the computer in one's room, and having research results available almost on real time imposed a totally different organization, especially of experimental research. Finally, the easiness of cut-and-paste tools enhanced content repetitions in successive works increasing plagiarism and demanding an enforcement of the academic ethos.

Additionally, fora like the Open Science Framework and the open access journals, despite various problems and constraints not yet circumvented, are initiating a new publishing culture, providing more opportunities for people to make their research results available, avoiding strict hierarchical structures, encouraging criticism as a way to promote "good science" and providing the means for the multifarious relations among academics.

1.1.2 Funding

Progressively the possibility of doing research has become dependent on the ability to find appropriate funding. Long gone are the days when universities themselves, or the relevant national ministries considered it their main responsibility to fund research. This is no longer valid, as both European, and corporate funding become more relevant. Being able to get funding has become *per se* a criterion of research excellence, thus enhancing the status of refereeing and referees who have become prominent stakeholders for the ways knowledge is created. But at the same time highly prestigious journals have been harshly criticized by reputed members of academia for having succumbed to economic pressures, putting heavily paid subscriptions and downloads at the center of their editorial activity. "Bringing in money" has become an end in itself, independent of the fact that initiatives on the part of many researchers and their groups have led to creative enterprises, innovations, and global networking. Simultaneously, there has been an increasing consensus towards accepting the production of knowledge as "something" similar to the production of goods. The acceptance of the commodification of academia has grown parallel with the decrease in the support of whatever does not bring commodifiable end results. It is not the first time that commodification of knowledge takes place in the history of universities and it is, thus, important to historicize commodification of knowledge in order to get a deeper understanding of how the academic research culture is being changed and how academic freedom is being affected.

The recent call for *Horizon 2020*, the new framework program for research and innovation, which will mold research in Europe during the coming decade, reveals an extreme utilitarian view of science dependent and justified by its capacity to generate innovation in and for society. Thus, it unveils a strong drift towards industry-oriented research, and even social sciences are geared towards issues framed under the umbrella of the so-called responsible research and innovation. In such context, the traditional communal and inclusive values of academia are being replaced by the secretive and competitive values of commerce. Many studies show that increasingly more people are denied information about results produced from research funded by industry. A survey led by the Harvard Medical School showed that nearly 50 % of geneticists reported that they were denied information, data or materials related to published research results at least once in three years, and 28 % could not confirm the accuracy of published results. Even results of PhD theses are put under embargo much in the same way as patents. All this will bring about dramatic changes to the very identity of scientists and to the social legitimacy of science.

1.1.3 Teaching

It has been repeatedly stressed that university teaching is not reducible to a training process leading students to a professional diploma. First and foremost, it has been a way to mold responsible and critically thinking citizens. Furthermore, it is a way to communicate and discuss research results, raise new questions and test new methodologies. Hence teaching and research, the production of new knowledge and its transmission have been, to a large extent, going hand in hand. However, teaching has been progressively undervalued and the role of teachers in class is being bureaucratized. Presently, the traditional ways of class teaching are being relegated to a secondary position vis-à-vis supposedly more effective methods such as massive open on line courses (MOOC) that substitute the physical presence of the professor, bring visibility to the universities and help in ranking hierarchization. The numbers of auditors of on line courses, often free, on the one hand democratize higher education teaching but, on the other, strengthen the elitist character of a small number of top universities, highly recognized world wide. At the same time the whole status of teaching personnel is radically redefined.

The increasing precariousness of teaching positions, the decrease of tenure track posts, high teaching class loads, and low salaries may easily lead to a highly asymmetrical model in which a growing fraction of the teaching staff is reduced to mere human capital, provider of classes in a regime of intellectual poverty.

1.1.4 Assessment

Assessment has been the catchword that together with innovation has shaped academic policy making. Assessment has been closely associated with a quantitative mentality presented by bureaucrats as a magical prescription. Almost all assessment procedures of both research and teaching are expressed through numbers: Overall rating, impact factor of journals, references to one's works, evaluation by students of their teachers, students per class, students' grades, and so on. What has been the net result of expressing academic life solely by numbers? What is the result of the overdominance of numbers having displaced qualitative views? What are the implications of forcing everything in academia to be expressed in numbers when substantive components of university life are non-quantifiable? How can one head towards a more balanced assessment of what is happening in the universities by including both quantitative and qualitative components? How can one encompass the specificities of different disciplinary fields with different traditions and publication patterns?

The prestige that numbers carry in our culture is due to the way they certify objectivity, a trend which gained momentum since the nineteenth century as the result of its application to society at large, and not only to the realm of exact sciences and techniques. Of course, numbers express something objective. However, the claim to objectivity through numbers is becoming a claim to a *particular kind of objectivity*. No number is independent of the process of counting, no number is independent of the *culture and the politics involved in the process of counting*. The ranking of universities, and the subsequent effects of the ranking process are indicative of a rearticulation of the objectivity associated with numbers and the politics of counting. And, thus, a new political aim has been in the making: *To achieve a new consensus around such a notion of continuously rearticulated objectivities.*

Assessment has not been something unknown to universities nor has it been avoided by researchers and teachers. In fact, academic life itself can be said to be synonymous with the very idea of assessment: The sheer fact that academic life is almost meaningless outside the ethos and norms of the scientific community one belongs to in a democratic society is the very essence of assessment. But what is being instituted through the new policies is an amazing reductionist process: Everything happening at the universities is being reduced to numbers. Such use of numbers is continuously redefining power relationships in society. Political power in its most general sense has been vying to control numbers because whoever controls numbers can *create multiple realities and different truths*. Numbers in this sense have become the gist of the hegemonic ideology. This is the only way political power can legitimize the channeling of funds, dictate directions of research, and decide about the future of established and new subjects.

1.2 The Painful Transition of European Universities

This new framework will force a deeper understanding of a longstanding issue which has been present all along in the history of the universities: The status of university education and research as public good and as part of public space. Values that generations of scholars have been taking for granted and considered as being unproblematic, neutral, and, almost, trivially true, are no longer self-evident and instead are charged with ideological and political views.

Back in 1959, C.P. Snow delivered his famous talk "The Two Cultures" on the divide between the sciences and humanities in the Western intellectual culture, considered as a major hindrance for the education of citizens who would be best equipped for dealing with the ever growing and more complicated global problems. Although the concept of a third culture was introduced later by Snow himself, and developed in the 1990s by John Brockman, and despite the success of a rhetoric of interdisciplinarity, it is now clear that the gap between the "two cultures" was never bridged. In fact, what looms as a great danger is the prospect of remaining with just one culture. The commodification of knowledge and the financial pressure upon universities has forced a view of humanities as luxury, due to their structural inability to produce goods. The consequences of such a viewpoint are catastrophic. The funding of the humanities is not an end in itself, but a process of re-articulating and critically assessing value systems based on tolerance, reflectivity and interdisciplinarity. The fact that we are at a juncture in which the consequences of our techno-scientific decisions may lead to a point of no-return (technological singularity) calls for an accrued responsibility of knowledge producers, which has to be anchored on civilizational values. Humanities provide the tools fundamental to such decision-making, remaining absolutely decisive for the better education of citizens, the cohesion of societies, and the critical judgment of what is happening in the public sphere. Humanities should remain at the core of the Humboldtian notion of the *Universitas* as self-reflexive disciplines, enabling to critically assess dominant ideologies, modes of thinking, and government. As presently they are indelibly tied to scientific research and teaching practices in the universities, they are absolutely decisive to build an integrated worldview, in which humanities and sciences are the two complementary sides of the same reality. They are, therefore, central to the solution of the major problems which we face and which define our future both as scholars as well as citizens.

Building an agenda for European universities mostly on the basis of comparisons to other university models, such as the American or the Asian, is doomed to fail. The long history of Europe, the specificities of humanistic values and their embodiment in shaping a model for universities should be the starting point for redefining Bologna. In this context, a reflection on the last 150 years of European universities –a date that approximately takes us to the beginnings of the modern universities– becomes imperative, as it unveils how cultural diversity and citizenship were critical for European leadership in innovation and scientific excellence. This book is a contribution to this aim.

1.3 Academic Landscapes. Sciences in the Universities of Europe, Nineteenth and Twentieth Centuries

The idea for this book has emerged roughly one year after the organization of the meeting History of European Universities. Challenges and Transformations, which took place at the University of Lisbon, on Easter 2011, on the occasion of the commemorations of the 100th anniversary of the University of Lisbon. This university was one among the many educational institutions created by the Republic, established in Portugal on 5 October 1910, to reform higher education, so as to mold the new republican elite and forge a new citizenship. Roughly 2 years after the meeting took place, in July 2013, the University of Lisbon merged with the Technical University of Lisbon, in what was the most significant event of the Portuguese academic landscape since the last years of the dictatorship and the onset of democracy on 25 April 1974, which opened the academic landscape to various new public universities and opened the institutions of higher education to many young people, more or less independent of class background. This event finally materialized the unfulfilled dream of the first rectors of the University of Lisbon whose mandate spanned the whole First Republic (1910–1926). It was the third rector, the mathematician Pedro José da Cunha (1867–1945), who strongly stressed that academic research should be at the core of both university teaching and outreach activities, and for whom the articulation of technical and humanistic dimensions in higher education were crucial to transform universities into potent agents of economic and social development. The new University of Lisbon is, thus, giving its first steps in the articulation of a scientific, cultural, and educational agenda, reinventing the gown and town relationship, and valorizing its rich patrimonial heritage in the context of the deep crisis impending on Portuguese society and Europe as a whole.

Scholarly contributions to the history of universities have been often pursued in the context of cultural history with little interaction with the history of science, and science policy and have tended to concentrate on medieval and early modern periods. This book focuses on sciences in the universities of Europe in the nineteenth and twentieth centuries, and aims at bridging the above disciplinary gap.

In the first part of this book, it is offered a discussion of several aspects of European universities in the longue durée, ranging from specific scientific disciplines to women students, governance debates, sociability networks, and enmeshments with the political context. In the second part, chapters assess the reactions and subsequent accommodations of universities to authoritarian, communist and fascist, landscapes. The third part explores the role of research within academia and the various appropriations of the Humboldtian research university model in different local, and often peripheral, milieus. Finally, in the fourth part, the formation and evolution of scientific disciplines within various university settings is under scrutiny. Generally, chapters address issues ranging from the specificities of academic landscapes in central and peripheral settings, local reactions to various university models vis-à-vis specific cultural and political contexts, to recent debates on the impact of the Bologna process and the commodification of knowledge. They have been assembled with the view that more than ever revisiting various dimensions of the last two centuries of European universities is crucial to the assessment of its present predicaments, on the way to informing future choices.

Part I
Universities in the longue durée

Chapter 2
"Those that Have Most Money Must Have Least Learning": Undergraduate Education at the University of Oxford in the Eighteenth and Early Nineteenth Centuries

Robert Wells

2.1 Oxford in the Eighteenth Century: The University in Decline?

In the University of Oxford's long and storied history, much of the eighteenth century has marked a low point in the university's reputation. The Oxford colleges have suffered a barrage of criticism from both contemporary writers and later historians for a perceived decline in the quality of scholarship and instruction compared to earlier and later periods. Commentators in the eighteenth century charged the colleges with everything from openly espousing Jacobitism, to encouraging social climbing, profligacy, and alcoholism in its students. Alumni and ex-students confirmed some or all of these accusations in their memoirs, letters, and other publications, including notable intellectuals and public figures like Edward Gibbon. As a result, many have found reason enough to condemn the period between the Glorious Revolution and the year 1800 as, in the words of John Henry Newman, "a century of inactivity" (Newman 1852, p. 4).

In *The Eighteenth Century*, volume five of the *History of the University of Oxford* series, editors L.S. Sutherland and L.G. Mitchell, along with the volume's other contributors, pushed back against this enduring characterization. In his introduction to the volume, Mitchell declared the need to reassess the quality of an Oxford education in this period by acknowledging the full range of testimonies available and understanding the contexts in which most criticisms of the university were made. He and the other authors placed Oxford amidst the greater political and religious tensions Britain experienced throughout the century in order to show why the university was such a convenient and persistent target for critics and reformers. They also demonstrated that important advances were made in research and educa-

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tion, and that the whole body of evidence reveals as many satisfied graduates as discontented ones (Sutherland and Mitchell 1986).

Although Sutherland, Mitchell et al.'s much-needed reappraisal is now the standard account of the period, and in spite of Mitchell's almost defensive insistence that "Gibbon can no longer be allowed to dominate the field," the disparaging remarks of such ex-students still loom large in most accounts (Mitchell 1986, p. 1). Part of the reason for this is the importance often ascribed to the Examination Statute of 1800 and its various successors in modernization histories of the University of Oxford. By making changes to the examinations most students underwent in their colleges, and introducing the first vestiges of the honours class system, the Statute and its supporters are said to have initiated a process of much-needed reform that improved academic discipline and made Oxford more meritocratic. The terms of these reforms were endlessly and heatedly negotiated throughout the first half of the nineteenth century amid religious tensions and fears of revolt, and Parliament itself eventually intervened with the Oxford University Act of 1854. Thus, when read with these later changes to the university curriculum and examination statutes in mind, accounts from students like Gibbon have often helped historians paint a convenient 'dark age' of idleness and profligacy that the early-nineteenth-century reforms are supposed to have dispelled.

In the most recent major treatment of eighteenth-century Oxford and the nineteenth-century reforms, Heather Ellis emphasizes continuity between the two rather than a radical break. She embeds the new examinations, the battles over the curriculum and tutorial system, and the religious conflicts surrounding Tractarianism within a longer history of conflict between the colleges and their undergraduates during the 'Age of Revolutions.' Going back well into the opening decades of the eighteenth century, Ellis argues that it was repeating cycles of Oxford faculty and administrators trying to control their increasingly unruly students that produced these changes in university education and governance. Rather than a battle of Ancients against Moderns over the classics and sciences, or the actions of a few liberal, meritocratic crusaders, she sees the introduction of new examinations and changes to the curriculum as a series of very conservative responses to what were perceived as constant political and intellectual threats to authority and order at Oxford.

Ellis's account is largely convincing and the challenge it poses to traditional periodizations of university history is especially welcome. But her narrative of continual conflict between junior and senior members of the Oxford colleges presupposes that at least one of these "interest groups" was more cohesive than the evidence indicates, especially in the eighteenth century (Ellis 2012, p. 4). She is right to argue for Oxford as a site of political conflict in the Age of Revolutions, not just an elite bastion against the revolutionary demands of the lower socio-economic classes without. "Instead of opposition drawn along class lines," she writes, "it is suggested that tensions within the ranks of the elite were frequently played out along the axis of youth and age, of generational difference." (Ellis 2012, p. 4) But significant differences between the undergraduates, or 'junior' college members, need to be acknowledged as well, for these distinctions were one of the most pervasive and frequently-discussed facts of college life.

Well into the nineteenth century, the Oxford colleges themselves separated their undergraduates into strict socio-economic classes that affected every aspect of college life. While students might emerge from Oxford with degrees and careers that eventually made them part of the British elite after graduating, many of them came from very humble backgrounds, and certainly did not live privileged lives at the university. Undergraduates were separated into one of five distinct ranks and granted or deprived college liberties according to the prominence of their station. This status depended upon the wealth and influence of a student's family rather than the student's own skill or desire to learn. These young men may have lived together in their colleges and studied roughly similar subjects, but they had a fixed position in Oxford society established by the colleges that they could not improve much through study alone.

While it may be tempting to dismiss this social hierarchy as secondary to the more important issues of education and governance within the college, and their connection to socio-political conditions in greater British society, a student's rank translated into more than just prestige within university society. It both determined the academic standards he needed to meet in order to take a degree and influenced the quality of the instruction he received. If a young man's parents paid enough money to enter him into the top two ranks of students, he was excused from most academic exercises and exams and could instead receive an honorary degree simply for remaining in residence long enough at the college. At the same time, these gentlemen students were highly sought after by tutors and members of the college faculty because of the high fees and patronage opportunities their families offered. This meant such students had access to a greater pool of potential instructors and often received more individual attention from qualified scholars than the rest of Oxford's undergraduates. Without many actual academic requirements to complete, however, fewer gentlemen students took advantage of such benefits.

It is exceedingly presumptuous to conclude from the writings of a few dozen ex-students and critics that the thousands of students who passed through Oxford's gates over the course of more than a century learned nothing or were all miserable during their college tenure. Yet we cannot treat their criticisms merely as vindictive or political attacks, especially when clear patterns emerge from them that point toward a very specific problem. Of the writers who disparaged their time at Oxford, those entered into the top two categories of students, the noblemen and gentlemen commoners, were most critical of the shocking lack of academic requirements and discipline they were subjected to while in residence. Individuals who fell into the other classes of students, the commoners, battelers, servitors, and other students on scholarship, more frequently complained about bad tutors, boring lessons, and a general lack of opportunities for intellectual stimulation. Certainly a student's experiences often depended on his tutor's ability and their relationship, as others have pointed out. But the clear divide among the experiences of the students studied here shows that the undergraduate class system could, and did, have notable effects on education in the colleges.

The two parts of this analysis will show that the tutorial and lecture systems functioning at Oxford in the eighteenth century combined with the formal student hierarchy to undermine the quality of undergraduate instruction in this period. The result of this system was that students with the most access to academic resources often had the least incentive to actually study and vice versa. There is no doubt that a talented, motivated undergraduate of any rank might have had a positive learning experience at Oxford in this period and there is plenty of evidence that many did. But the degree to which this depended on factors like the skill and character of a student's tutor, as well as his access to other knowledgeable men and books, meant that financial and political resources were of great importance. For the colleges and tutors to often allow, even encourage, students with those assets to do everything but dedicate them to their education meant that the attention and skills of many instructors were misemployed and opportunities were further limited for less-wealthy students. As a result, it should not be surprising that intellectual curiosity and discipline suffered across all ranks of Oxford undergraduates at various points in time.

2.2 The Oxford Student Ranks

Before pursuing this analysis further, it is necessary for readers to have a basic understanding of what university life and the undergraduate ranks were like at Oxford in the early modern period. While different statutes and practices under different headmasters meant that some variation existed between the individual colleges throughout the eighteenth century, a general overview of how the undergraduates were organized will have to suffice here. Plenty of detailed studies are available and highly recommended for a more complete picture.[1]

The Oxford colleges created and maintained a class structure that was both more conspicuous in its external markers and operative privileges, and more fluid as a result of its dependence on payable fees, than existed throughout most of British society. At the top of Oxford's five different ranks of undergraduates were the noblemen and gentlemen commoners. Drawn only from the ranks of the British peerage, the extraordinary wealth and prestige of noblemen students made them celebrities not just of their colleges, but the entire university. Such privileged individuals were very few in number at Oxford compared to the other students, and it was a mark of distinction for a college to attract them. Peers also frequently entered their sons as gentlemen commoners, a title that carried many of the same privileges as that of a nobleman, but this rank of student was more readily associated with the sons of the landed gentry and other wealthy gentlemen. These distinguished positions were reflected in the clothes students were required to wear everywhere: luxurious silk gowns with elaborate lace patterns (gold or silver for the noblemen) and tasseled caps (gold again for the noblemen) (Salmon 1744, p. 422; Midgley 1996, pp. 11–15).

[1] The quote in the article's title is from Amhurst (1726, p. 47). For excellent descriptions of student life and the student ranks at Oxford in the eighteenth century more generally, see Bennett (1986); Green (1986); Midgley (1996). Individual college histories also contain detailed information, such as Bill (1988) and Jones (1988).

What really set the noblemen and gentlemen commoners apart from the other students were the liberties their rank afforded them in daily college life. These lucky young men were freed from academic requirements and would receive an honorary bachelor's degree if they stayed at Oxford for a few years (and sometimes a master's degree as well).[2] This allowed them to focus on other social pursuits considered more appropriate for a gentleman, such as developing relationships with the university faculty and other important men. According to Thomas Salmon, noblemen eat "with the Fellows, and have private Tutors usually, but do not seem to be subject to the Rules of the University any further than they please" (Salmon 1744, p. 422). Besides sharing such important privileges, the very small number of students who enrolled as noblemen makes it appropriate to discuss them and gentlemen commoners together because the latter usually represented the highest rank of undergraduate in a college at any given moment. Whereas Wadham College hosted only a handful of students with nobleman status over the course of the century, Christ Church, for example, enrolled more peers as noblemen and gentlemen commoners than all of the rest of the colleges combined (Gardiner 1895; Cannon 1984, pp. 48–51).

Students acquired these places of prestige in the Oxford community and the freedoms associated with them by literally purchasing them from the colleges. Fees payable to the college for enrollment, tutoring, room and board, meals, and other goods or services were highest for noblemen on down to the lowest rank of student, the servitor, who paid comparatively little. Thomas Salmon reported that gentlemen commoners paid roughly twice as much per quarter for tuition as commoners (Salmon 1744, p. 423). That hardly compared to the expenses that noblemen incurred, however: keeping the dignity of their title at Oxford was a very costly enterprise. A letter written by Dr Joseph Hunt, Master of Balliol College, spelled this out clearly:

> Sir James Harrington may, if he pleases, drop his title and be admitted a Gentleman Commoner of our College: and if he shall chuse to do so I will find him a Tutor for whose care of him I will be answerable. The expense will then be, with prudent management, abt. £ 20 a year. If he should keep his Title then I cou'd take care of him myself and the expense wou'd be £ 200 a year. I would not care to agree for less for his tuition than Sir John Napier pays me for his but would leave that matter to his Guardians to do as they would think fit.[3]

Although Harrington's family decided gentleman commoner status was good enough, others were not willing to put a price on their honor. The fabulously wealthy James Brydges, 1st Duke of Chandos, paid at least £ 400 to keep his son, the Marquis of Carnarvon, along with "a servant, a footman, a groom, and three horses" at Balliol College for a year (Baker and Baker 1949, pp. 101–102). That did not even include additional money the Duke paid to both the master of the college and to the Marquis's personal tutor (the same Joseph Hunt mentioned above) who were jointly

[2] Thomas Hunt mentions gentlemen commoners receiving honorary M.A.s in Letters to Richard Rawlinson dated July 4, 1743 and December 9, 1745. Bodleian Library, University of Oxford, MS Rawl. letters 96 fol. 105 and 223.

[3] Joseph Hunt to Hilkiah Bedford, 11 March 1723, Bodleian Library, University of Oxford, MS Rawl. letters 45 fol. 172.

responsible for his son's education: each received a further £ 200, and the charges for Hunt's D.D. degree were paid.

After the gentlemen students came the commoners, the most numerous class of students. Since meals were the central organizing principle of the college day, the name commoner was derived from the practice requiring all such students to eat meals, or commons, together in their college dining hall. These boys were most often the sons of clergymen or any tradesmen of moderate wealth, but they could also come from the ranks of prominent families if their parents did not feel official gentleman status was worth the additional costs. E.G.W. Bill asserts in his excellent history of Christ Church that the gulf between gentlemen commoners and commoners was a narrow one as a result (Bill 1988). Yet because Christ Church was exceptional for enrolling so many wealthy, titled students as noblemen and gentlemen commoners, the latter probably did not stand out as much as they did elsewhere; the lack of noblemen at Wadham and other colleges meant the gentlemen commoners occupied the top undergraduate rank there. Unlike the gentlemen students, commoners did not lead lives of luxury or hold noteworthy titles, but their position was usually respectable enough for them to avoid deprecation on its basis alone. Their dress reflected this status: they wore basic gowns of wool that were not full length and did not have sleeves. There is some confusion over whether they wore tassels on their caps, something that may have varied by college, but at least during Jeremy Bentham's time at Queen's College they seemed to.[4]

In contrast to the gentlemen students, commoners were under more scrutiny from the college faculty, particularly the men who they either hired or had assigned to them as their tutors. Commoners were required to go to lectures and lessons, to study afterwards at regular intervals, and might be punished for lax attendance or any number of other gaffes. Part teacher, part supervisor, tutors were really the only people responsible for their assigned students on a day-to-day basis. While noblemen and gentlemen commoners were mostly relieved of such surveillance, tutors could exert a good deal of control over other students if they were so inclined. The anonymous author of *Memoirs of an Oxford Scholar* was dismayed to find that all of his school funds had been left in the hands of his tutor, and instead made a habit of purchasing items on credit rather than trying to pry the money away from him. The author's plan to visit a sweetheart in London was also frustrated by his tutor's diligence, who explained that he had "particular Instructions from your Father not to let you lye a Night out of College, without his orders" (Anon 1756, p. 44). Obnoxious to the student or not, such a dutiful tutor was quite the blessing for a parent concerned with their son's progress. None of the liberties afforded to the noblemen or gentleman commoners were extended to commoners and thus they led regimented lives, at least in theory.

The presence of the non-commoner students at Oxford probably prevented commoners from ever complaining too much about their situation. Each college had its

[4] Midgley (1996, pp. 13–14) states that commoners did not wear tassels on their caps, but a shopping list followed by Jeremy Bentham's father for outfitting his son included a tassel (Bentham and Bowring 1843, pp. 36).

own financial resources, some of which might be put towards helping talented (or well-connected) students attend at lower cost than others. These included a rather irregular range of studentships, scholarships, exhibitions, and foundations often established by individual benefactors that might confer a certain amount of prestige on the students holding them. Other financial aid from the colleges came at a price, however, and students who entered as either battelers or servitors were marked as distinctly inferior to the commoners. The term 'battels' refers to a student's accounts with the college, including their meals, and Thomas Salmon explains that "battelers" purchased their food and drink directly from the college buttery and ate in their rooms. While costs were lower for them as a result, they were thus denied access to eating and socializing "in common" with most of the college in the dining hall (Salmon 1744, pp. 423–424).

Servitors were the lowest order of students at Oxford throughout the seventeenth and eighteenth centuries and the model of a destitute scholar. Ideally when the son of a poor family (or maybe a second or third son from a more bourgeois background) distinguished himself by his academic achievement and was recommended to an Oxford college, there was a decent chance the university would take him in. A young man might also enter as a servitor if he came to Oxford as the personal retainer of a gentleman student. Servitors studied in the same manner as the other students, proceeded to the same degrees, and also had a tutor, but paid far less for room and board than commoners. George Whitefield's mother was inspired to send him to Pembroke College when a former schoolfellow "told her how he had discharged all college expenses that quarter, and received a penny" as a servitor there (Whitefield 1960, p. 42). Such a situation was possible because, in addition to paying low fees, servitors were often able to make additional money performing all sorts of odd-jobs for other students or scholars of the college.

Their college's generosity came at a cost, however, and a servitor was identified in student society by his poverty. Their gowns might be similar to those of the commoners, but servitors were the only rank of students not permitted to wear the square hat of a scholar. They were made to wear round hats instead, cheap, awkward pieces of fabric that marked their wearers as conspicuously inferior to the other students. They were not allowed to take commons with the other students, but they were permitted entrance to the dining hall and kitchen in a unique capacity: as meal servers to the rest of the college.

The position of servitor at Oxford drew criticism from contemporaries for its subjection of one student to another even while both studied identical subjects in their college and might come from similar backgrounds. George Fothergill was of a respectable family with Oxford connections and entering at Queen's College Oxford in such a servile state was a rude awakening for him. He was relieved that at least his age prevented him from being named the "junior servitor", thus saving him from "a slavery which I always dreaded, and could not well have undergone" (Thornton and McLaughlin 1905, p. 79). Having worked in his family's tavern since he was a child, George Whitefield found the position less mortifying than Fothergill did. When he became interested in studying religion with the Wesley brothers, however, he had to contact them secretly out of fear that his low station would offend them (Dallimore 1970, p. 65; Whitefield 1960, p. 46, 50). The poets Richard Jago and William Shenstone came from similar backgrounds and were close friends in grammar school, but after Jago entered as a servitor at University College and Shenstone became a commoner at Pembroke College, they suddenly had to start meeting in secret because of Jago's low rank. Both were successful gentlemen in later life and maintained frequent contact with each other, but their time at Oxford represented a strange anomaly in an otherwise close friendship (Davenport 1822, pp. 119–120; Graves and Seward 1788, pp. 27–30).

While a student's social standing might subject him to, or protect him from, varying degrees of embarrassment, it was in no way a signifier of academic success at Oxford in the eighteenth century. Nobody understood this better than Joseph Hoare, Principal of Jesus College in the middle of the century, and one of his students, William Jones. Hoare made the interesting decision to enter his nephew at Jesus College as a servitor when the boy could easily have entered with a different student rank. The nephew of an important man should have been safe from the daily humiliations of such a station, but far from wanting to punish his nephew with this role, Jones explained that Hoare enrolled the boy as a servitor "in order to render the young man more studious than he might have been." This plan failed, however, "for Master Lewis, being more than commonly handsome and shewy, and not bookishly inclined, exhibited his well-dressed person … as much as he could have done, if his cap and gown had not been plain" (Jenkins 1908, pp. 74–75). Hoare personally valued education and discipline enough to place his nephew where he would make the most progress. Yet for that place to be the lowest, most embarrassing position in the college shows that some pursuits were held in higher regard at Oxford than learning in this period.

2.3 The Oxford Gentleman and a Different Education

Among the most common exercises that undergraduates performed at Oxford in the early modern period were oral disputations. In order to demonstrate their skills in logical reasoning and public speaking, as well as their knowledge of different subjects, classmates either answered questions or defended different positions in front of their tutor or other college authorities. Yet in a 1722 letter to his uncle, Nicholas Toke explained the difficulties of practicing or participating in these disputations as a gentleman commoner of University College:

> I have long ago gone thro' Fells Logick; but have not those opportunities, I could wish, of improving my knowledge in that Science; & knowing ye bare Rules only of any art, without putting 'em in practice, will certainly signifie but little. For Gentlemen Commoners, tho they have many opportunities of getting improvement by ye best Company, may under this great disadvantage of not improving their learning so much as other inferior gowns in ye University. I might indeed go into ye Hall to Disputations; & should willingly perform all ye Exercise of an Under-graduate; but then I should draw upon me ye hatred of all ye Gentlemen of my own Gown, be guilty of great singularity (which in all places is to be

> avoided) & be accounted a Person proud of his own performances, & fond of shewing his parts.[5]

By acknowledging here that gentlemen commoners had the most access to instructors and other pedagogical resources, but little incentive to actually use them, Toke clearly expresses the contradiction that lay at the heart of undergraduate education at Oxford. Although receptive to his uncle's advice about the importance of disputations and personally interested in them himself, Toke pointed toward the minefield of different expectations and standards which undergraduates had to navigate. Despite the efforts of some individual headmasters (those at Christ Church in particular) the colleges widely failed to convince their gentlemen students that participating in even basic educational exercises would not compromise their honour or position. In fact, they often taught them just the opposite.

Numerous scholars have identified changing attitudes toward education among the British elite in the long eighteenth century as experience and worldliness came to be judged more important than formal Latin training. As James Rosenheim points out, sending a son to acquire an experiential education on the expensive (and oft-studied) Grand Tour "had the added virtue of very efficiently performing education's less explicit objective, that of distinguishing the true gentleman from those who would mimic him." (Rosenheim 1998, pp. 34–35) Oxford educators also adjusted to these changing demands throughout the eighteenth century by offering parents more opportunities to pay for lofty college titles so that their sons would learn to live independently as proper gentlemen in the safe, enclosed environment of the college. Rather than making them complete typical undergraduate exercises, the colleges allowed gentlemen students more time to participate in social activities that were deemed suitable for and crucial to the performance of politeness or civility.[6] This meant freeing them to participate in activities like horse riding and hunting, as well as helping them refine their tastes and social skills through frequent interaction with classmates of their rank, the college faculty, and other notable men associated with the university.

The university's ability to designate student rank and privilege on its own terms created demand for places of distinction in the insulated society of Oxford. How these titles played on the pressures of maintaining or building a family's social respectability can be seen in the following letter from Theophilus Leigh to his sister:

> My nephew being your eldest son, and Heir to a good estate, which will quickly be known there, without possibility of concealment I think indeed you ought to allow him £ 100 by the Year. Our Cosin Chamberlayne allowed his Son as much, and he spent much more. You must of necessity enter him a Gentleman Commoner. It will be otherwise very reflective upon You, and discouraging to him. Such as were Commoners in my time, are … Gentlemen Commoners now. (Bennett 1986, p. 374)

[5] Nicholas Toke to Dr. Thomas Brett, Jan 15 [1722], Bodleian Library, University of Oxford MS Eng. th. c. 27 fols. 365–366.

[6] On the many faces of "politeness" in the British long eighteenth century, see the seminal article by Klein (2002).

Leigh warned his sister not to risk the honour of his nephew or the family by entering the boy in a position where others might consider him inferior. He also commented that commoner status was not as respectable as it had once been, suggesting that standards at Oxford had changed over time as families placed their sons in better and better positions. This parallels the concerns of eighteenth-century critics like Thomas Salmon who worried that Oxford colleges allowed a certain degree of social climbing to take place within the student ranks. Salmon noted that baronets and their sons were often allowed to enroll as noblemen, for example, a point confirmed by Erasmus Philipps, a gentleman commoner at Pembroke College, when he named one such baronet-nobleman as Sir Walter Bagott (Salmon 1744, p. 284, 422; Phillips 1860, p. 366). William Jones likewise complained that he was considered "plebeian" while his classmates from grammar school, who were "of the same class in life" as himself, were entered as the sons of "gentlemen" (Jenkins 1908, pp. 74).

Rather than lineage acting as a rigid indicator of social status, a student's position at Oxford in the eighteenth century was almost entirely dependent on the financial resources available to him. In addition to the position purchased when a student was entered at his college, a culture of conspicuous consumption reigned in which the true costs of being a gentleman student built up through the living of a certain lifestyle. Those students of less-wealthy families were priced out not just through inflated fees, but the expectation that noblemen and gentlemen commoners would take advantage of the liberties afforded to them. High-end clothes and apartment furnishings were a necessity, while polite hobbies like hunting and riding horses were not cheap activities because they entailed keeping dogs and horses at the college or renting space in town. The ability to spend money and move in proper circles thus demarcated the upper crust of students in college society as much as their titles did. As has already been mentioned, Dr Hoare's nephew Lewis was able to at least partly transcend his low position at Jesus College by otherwise dressing and acting as "if his cap and gown had not been plain" (Jenkins 1908, p. 75). Despite Theophilus Leigh's concerns, the Brasenose College Register makes it clear that it was not uncommon for boys to enter as commoners and then move up to the rank of gentleman commoner later, perhaps after they had realized the benefits that accompanied the change in status. All they needed to do was pay the additional fees and do what was necessary to fit in.

Gowns were the most conspicuous signifiers of a student's rank and the ones designated for gentlemen students were priced accordingly. When his two sons were gentlemen commoners at Oriel College, the "Fine silk Gent. Commoner's gown" appropriate to their station cost John Lovell (the elder) more than £ 10 each, which was about the price of a half year's tuition.[7] Just as Theophilus Leigh had advised his sister, it was recommended to Robert Pitt that he provide his son William with £ 100 to cover his enrollment as a gentleman commoner at Trinity College. Actual university fees were much less than that, but in order for William to fit in as a gentleman commoner, it was necessary for him to bring a personal servant and to give a substantial benefaction and "Piece of Plate" to the college (Mallett 1927,

[7] Wiltshire and Swindon History Centre, MS. 161 bundle 159/ NRA 7427 Francis.

pp. 70–71). This fits with evidence from the Brasenose Registers, which show that the practice of donating at least £ 10 worth of plate or other furnishings to the college was ubiquitous amongst gentlemen commoners (Heberden 1909). Costs for meals, classes, furnishings, and other "Conveniences that young Gentlemen don't care to be without" ended up forcing young William to ask for another £ 47 to cover his expenses for the year (Mallet 1927, pp. 70–71).

It was also necessary for the noblemen and gentlemen commoners to maintain a certain style and etiquette during the nights of dancing and drinking which were common across all ranks. Erasmus Philipps threw a "Private Ball" along with seven or so other gentleman commoners in honour of a group of young ladies (Phillips 1860, p. 444). A gentleman student could spend his nights drinking heavily if he so desired, but he had better do it off of expensive, classy liquor. When Richard Graves entered Pembroke College as an Abingdon Scholar he made friends while moving through very specific groups of students. One set drank and smoked copiously, but were judged "very low company" by some of Graves' gentleman commoner friends because they preferred ale. Graves reports that these gentlemen were just as raucous, but their tastes were more refined:

> They treated me with port-wine and arrack-punch; and now and then, when they had drank so much, as hardly to distinguish wine from water, they would conclude with a bottle or two of claret. They kept late hours; drank their favorite toasts on their knees; and, in short, were what were then called "bucks of the first head." This was deemed good company and high life: but it neither suited my taste, my fortune, or my constitution. (Graves and Seward 1788, p. 16)

Notice Graves's comment about their style of living not agreeing with his "fortune". Although not of their rank at Oxford, Graves fell in with these gentlemen commoners because they were also from Gloucestershire and all got along well. Unless he wanted to go deep into debt, however, he simply could not afford to participate in the same activities as them.

Granting the noblemen and gentlemen commoners the leisure time to pursue their own fancies meant that daily educational exercises were often the first thing they were excused from. The Earl of Malmesbury reported the following of his experiences at Merton College from 1763 to 1765:

> A Gentleman Commoner was under no restraint, and never called upon to attend either lectures, or chapel, or hall. My tutor, an excellent and worthy man, according to the practice of all tutors at that moment, gave himself no concern about his pupils. I never saw him but during a fortnight when I took it into my head to be taught trigonometry. (Harris 1844: ix)

In typical fashion for students of this period, Malmesbury spoke highly of his tutor's character but highlighted his failings as a disciplinarian. Malmesbury was actually fortunate to have a tutor who could teach him trigonometry, which was considered particularly appropriate for gentlemen to have some knowledge of, in addition to the usual study of Latin and the classics. Whereas other students might have jumped at the opportunity, as will be shown later, he does not seem to have really taken advantage of his tutor's skill in this area. Likewise, when the brothers Gilbert and Hugh Elliot came to Christ Church in 1768, Dean Markham advised them to study more than just the usual curriculum because he believed gentlemen should understand mathematics and other subjects as well. But this encouragement was quickly undercut in practice because, according to Gilbert, college life "had a most narcotic influence, and seems to set young men to sleep at some of the most naturally wide-awake years of their life." The son of a baronet, he was not held responsible for any college duties or to his tutor for any exercises, preferring to spend his time at cricket (Minto 1874, p. 39).

Equally important to maintaining a certain image and moving in the right circles of undergraduates was a student's ability to conduct himself amongst older men of the college. Noblemen and gentleman commoners were expected to regularly mix with different members of the college faculty. The most important example of this tendency was the practice of allowing noblemen and gentlemen commoners into the senior fellow's common room and to eat at the faculty's table in the dining hall. In a 1778 letter to his mother, Peter Harvey Lovell described his daily routine as a gentleman commoner in the following manner:

> We go to Prayers every Morning at 8 o clock, then go to Breakfast, & after Breakfast to Lecture, then leisurely dispose of ourselves as we please till Dinner time about 3 o clock, after which retire to the common Room (a Room to which the Gentlemen Commoners, & Fellows of the College only have Admission) & there drink a Glass or two of Wine, & after sitting about an Hour & half go to Prayers in the Chapel, then drink Tea at our own Chambers, & sup in the Common Room if we choose.[8]

This schedule shows how gentlemen students were often kept in a very different orbit from the rest of the undergraduates. Their bills indicate that the brothers were indeed in the Oriel common room for at least a glass of port or sherry most every day and sometimes for food as well. There were also other opportunities to meet scholars and gentlemen in more formal settings, as when Erasmus Philipps attended an "extreamly Elegant" dinner party in the Marquis of Carnarvon's rooms at Balliol with some independent gentlemen and fellows of the college (Phillips 1860, p. 366).

As has already been noted, one of the most high-profile critics of eighteenth-century Oxford education was Edward Gibbon, who called the fourteen months he spent as a gentleman commoner at Magdalen College "the most idle and unprofitable of my whole life." Despite having great respect for the personal character of his first tutor at Magdalen, he did not hesitate to call him a poor teacher: "the sum of my improvement in the university of Oxford is confined to three or four Latin plays," he writes. Like Malmesbury's tutor, Mr. Waldegrave's major failing was as a disciplinarian to the young Gibbon:

> I was once tempted to try the experiment of a formal apology. The apology was accepted with a smile. I repeated the offence with less ceremony; the excuse was admitted with the same indulgence: the slightest motive of laziness or indisposition, the most trifling avocation at home or abroad, was allowed as a worthy impediment; nor did my tutor appear conscious of my absence or neglect… No plan of study was recommended for my use; no exercises were prescribed for his inspection; and, at the most precious season of youth, whole days and weeks were suffered to elapse without labour or amusement, without advice or account. (Gibbon 1796, p. 40)

[8] Wiltshire and Swindon History Centre, MS. 161 bundle 159/ NRA 7427 Francis.

Obviously it is not fair to heap all of the blame on the teacher when his student so resolutely dedicated himself to avoiding work, but it should not be a surprise that allowing a fifteen year-old boy to shirk his studies without any fear of reprobation would produce such a situation. With more than enough money from his father, Gibbon enjoyed travelling: he visited Bath, Buckinghamshire, and made numerous trips to London. Nobody else in the college made a big deal of these tours or his frequent absences because he both had the means to do so and was a gentleman commoner, whose "velvet cap was the cap of liberty." Waldegrave and Gibbon would regularly take walks and discuss different things, but he seems to have been comfortable with Gibbon's interests lying elsewhere. When Mr. Waldegrave left the college for a post elsewhere, his student discovered that he had been a comparatively diligent master: Gibbon visited his next tutor only once in eight months, and that meeting was his own idea (Gibbon 1796, p. 42).

As the cases of Malmesbury and the Elliot brothers show, the colleges often did little to encourage, nevertheless pressure, prospective gentlemen to spend either their time or money actually learning. At the same time, however, there were plenty of opportunities for young men of means to study the subjects that interested them because students with money or influence could hire additional instructors and pay to attend other lecture courses. The high fees they usually paid their tutors meant that most faculty members would be happy to take them in, not to mention that one of the best ways for fellows and scholars to improve their career prospects was to be a tutor to the right student. It has already been noted that both the college master and a senior fellow supervised the Marquis of Carnarvon at Balliol, and that both were paid huge sums for their service. As a fellow of Magdalen College in 1776, John Parkinson jumped at the opportunity to tutor the son of an unnamed nobleman, and headed to London to meet his prospective employer. Although the trip ended in disappointment for Parkinson, his eagerness illustrates how important and highly sought after such patronage opportunities were.[9]

Gentlemen students could also contract men from outside of Oxford to reside with them at a college and act as their tutor. Lord Maitland brought Andrew Dalzel, Professor of Greek at the University of Edinburgh, with him as his tutor to Trinity College for a term in 1775. Although he appreciated that the Trinity Fellows made him feel welcome, Dalzel commented that "very little study goes on at Oxford except among a few book-worms that shut themselves up, and do not associate with others" (Innes 1861, pp. 13–14). When Thomas Parker (later 3rd Earl of Macclesfield) went to Hertford College, he was accompanied by Thomas Hunt, the family chaplain and his boyhood tutor. Already a talented orientalist scholar, Hunt went on to become the Laudian Professor of Arabic and Regius Professor of Hebrew at Oxford, as well as a Fellow of the Royal Society.

By encouraging the aspiring gentlemen students to distinguish themselves in ways that often had nothing to do with study, the student hierarchy helped ensure that both the resources of students and the instructional resources of the colleges were misused. This is not to say that all of these gentlemanly students entirely

[9] John Parkinson to mother, May 20 1776, Lincolnshire Archives, MS. 1-DIXON/16/4/2.

avoided their studies or were neglected by their tutors. It seems that Peter Harvey Lovell's tutor, John Eveleigh, was able to keep Peter and his brother attending lectures in the morning, while Nicholas Toke promised he would spend eight hours per day studying after being censured by his uncle.[10] But few gentlemen students had diligent direction from such men during their Oxford careers. Eveleigh was later a famous reformer of undergraduate education as Provost of Oriel College whose efforts culminated in the Examination Statute of 1800, while Toke's uncle was Dr Thomas Brett, a nonjuring bishop and prolific author. Overall, there were few people willing to push these young men at an important stage in their intellectual development, and plenty of pressure to do just the opposite.

2.4 Limited Opportunities for Poor Students

One might hope that allowing the gentlemen students to neglect their studies did not affect the other students or perhaps even helped the colleges provide more attention and lessons to those who needed it. After all, students of lower status had plenty of incentive to study because they did not receive any honorary degrees, they had less money to spend, and their futures were less secure. They were more likely to compete for financial rewards offered (ideally) on the basis of academic merit and then fight for employment in the church or at the colleges after graduating. Finding a wealthy patron might have been the real route to success, but advanced degrees were a necessity for those with fewer connections, and scholarly distinctions were also helpful. Yet the reality of the situation was that the colleges' instructional resources, namely the time and attention of able tutors and lecturers, were allotted first to those with the least use for them and all ranks of students suffered as a result. Students of commoner rank and below could not afford to bring a personal tutor with them to Oxford or pay for the individual attention of a senior fellow, and instead were usually assigned to junior faculty and tutors. While these men might be perfectly qualified, they were paid less, had more students to care for, and lacked the connections and resources of the senior college scholars. This meant curious students of commoner rank and below had fewer options if there was a specific subject they were interested in or an instructor they particularly liked.

Attending the additional lectures given by professors, fellows, and other individuals across the university was one way for students to pursue subjects that interested them, or at least receive instruction from somebody other than their tutor. Historians have often failed to recognize that these lectures were not cheap, however, and therefore it was not such an obvious decision for students to attend anything as they pleased. As G.R. Evans writes in her recent history of Oxford, occasionally "a generous academic could provide lectures free, but this was highly unusual. The rarity of such 'offers' cannot be overemphasized." (Evans 2010, p. 192) John James,

[10] Nicholas Toke to Dr. Thomas Brett, Dec 12 1723, Bodleian Library, University of Oxford, MS Eng. Th. C. 28 fols. 233–236.

a commoner at Queen's College from 1778 to 1782, does record having attended some divinity lectures by a Dr Wheeler at Christ Church for free. He was also lucky enough to be able to pay £ 3 for lectures given by William Scott, Professor of Ancient History at University College. He had to ask his father, however, if he should attend other lectures by "Hornsby, Professor of Astronomy, Williamson of Mathematics, and the Vinerian Professor," each of which cost "two guineas for the first course, one the second, and for ever after gratis." (Radcliffe and James 1888, pp. 93–94). William Blackstone's famous lectures on English law cost a full £ 6, but his reputation and their subject matter still attracted many listeners, many of whom were more advanced students. To put such amounts into perspective, the two tutors competing for students at Queen's College when Jeremy Bentham was there a few years earlier charged £ 6 and £ 8 for commoner students, so the costs of these additional lectures could be quite substantial (Bentham and Bowring 1843, pp. 37–38). These were still important opportunities for students to take advantage of because they allowed curious individuals to study topics that their own tutors might not be well versed in. When asking about attending the lectures, for example, James hinted to his father that his tutor, Mr Nicolson, intended to teach him mathematics, but was struggling to put a course together.

As at Queen's in Jeremy Bentham's time, colleges often had two men employed on a permanent basis as public tutors attending to the majority of undergraduates, unless separate arrangements were made with other fellows of the college or outside individuals. Given how many men occupied these posts across all the colleges in the eighteenth century, it is difficult to ascertain their qualifications compared to their other colleagues. There is no reason to think the majority of them were any less-knowledgeable than other college fellows or the college master; it was quite possible to catch a young, talented individual before he was promoted through the university ranks or took up a position in the Church. Before he became Professor of Ancient History, a Fellow of the Royal Society, and eventually a Baron, for example, William Scott was a tutor at University College from 1765 to 1775.

Regardless of their personal character or actual teaching ability, however, these tutors were obligated to more students than a college master or private instructor brought in from outside the university. In his last years as a tutor, William Scott was responsible for two-thirds of the students and "doing double work" compared to the other active tutor (Twiss 1844, p. 91). Some of these men surely cared enough to encourage study and discipline, but their attention was often split among numerous students and they were paid far less per pupil than scholars who may only have catered to one or two gentlemen students at a time. Whether they met with their students altogether in groups, or instructed them individually, it was more difficult to tailor lessons to the capacities of each individual. Jeremy Bentham complained that his tutor at Queen's College gave him and the other students lessons that Bentham had already accomplished in grammar school, a common complaint of Oxford education that would echo throughout the eighteenth and nineteenth centuries (Bentham and Bowring 1843, pp. 37–38; Ellis 2012). Although Bentham generally had little good to say about his tutor, Mr Jefferson, even talented and caring tutors would have had a more difficult time with students of different educational backgrounds.

A major difference between the testimonies of students who entered Oxford as gentlemen and those who did not is that the latter usually mentioned being expected to perform some sort of exercises, and their complaints were more specific to the quality of their tutor's lessons. These they often described as boring, uninspiring, and lacking structure or variety. A wealthy student entering as a nobleman or gentleman commoner had more flexibility in what college he entered, who he studied with, and what he studied, but the rest of the students were often stuck together with whoever happened to be employed at their college. This would force the students to focus on areas that their tutor could teach more readily, but which might not interest them. In a 1778 letter to a friend, John James's father complained specifically of such "modes of education" at Oxford, "if indeed those may be called modes of education, where no mode – no plan – not even a book, beyond a logic or ethic compend, is recommended." Oxford had such resources that "much may be expected from a lad of spirit – but from tutors, I verily believe, *nothing*" (Radcliffe and James 1888, p. 53). Thomas Frognall Dibdin agreed that "College exercises were trite, dull, and uninstructive" during his time as a commoner at St. John's College. "The University partook of this distressing somnolency. There seemed to be no spur to emulation and excellence. Whatever was done, was to be done only by means of private energy and enthusiasm." (Dibdin 1836, pp. 92–95) Although he attended his tutor as expected, and respected him as a person, Dibdin went a few terms without an actual reading curriculum. In his third year, frustration moved him to set up a sort of reading group with other students independent of their colleges and tutors.

For the talent and dedication he displayed in spite of his poverty, Samuel Johnson's time as a commoner at Pembroke College contrasted mightily with that of Gibbon's equally short reign at Magdalen. Like Gibbon, Johnson was responsible to two consecutive tutors while at Pembroke, both of whom he thought highly of on a personal level. The first, Mr William Jordan (or Jorden), Johnson described as "a very worthy man, but a heavy man, and I did not profit much from his instructions. Indeed, I did not attend him much. The first day after I came to college, I waited upon him, and then staid away four." (Boswell 1791, p. 25) Sir John Hawkins reported that Johnson would rather pay small fines for missing his lessons, even though he was already short of money, than waste his time with them. He instead pursued a very irregular curriculum of his own invention, reading as his fancy carried him from Greek, to metaphysics, to theology. When Jordan left the college, Johnson got lucky with his next tutor, William Adams, who eventually went on to become master of the college itself. Despite Hawkins' claims to the contrary, Boswell explains that Johnson was never able to study with Adams, however, because a lack of funds forced him to leave Oxford just before Adams was to take over his instruction (Hawkins 1787, pp. 11–12; Boswell 1791, pp. 34–35).

While Johnson always spoke very highly of his experiences at Oxford, and could accurately be described as somebody who embraced the life of a serious scholar early in his youth, he nonetheless acknowledged the obvious shortcomings in the instruction he received. Before he left the university, a friend of his named Taylor had hoped to join him at Pembroke. Speaking from his own experiences, however, Johnson "told Taylor that he could not, in conscience, suffer him to enter where he knew he could not have an able tutor." He searched the university for the best instructor he could find before eventually recommending that his friend try to enter under Mr Bateman, who was then a tutor at Christ Church. Interested to hear Bateman's lectures, but not allowed to attend them himself, Johnson would go over to Christ Church to get them from Taylor. Eventually, however, his ragged shoes marked him out to the Christ Church students and Johnson stopped going so as to avoid their stares (Boswell 1791, pp. 33–34).

2.5 Jeremy Bentham and Vicesimus Knox

Like Johnson, Jeremy Bentham also distinguished himself as a student of prodigious abilities and was admitted to Queen's College at only twelve years of age. As a commoner, Bentham had to actually complete exercises: he composed poems, wrote translations and gave declamations. The last of these he truly seemed to enjoy, but he still had little good to say about his experiences at Oxford. He hated Mr Jefferson, who only expressed contempt and annoyance when Bentham did better in his assignments than the other students, rather than being pleased with his student's abilities and challenging him more (Bentham and Bowring 1843, pp. 37–38). Bentham actually found a chemistry professor named Dr Smith whom he was interested in learning from at one point, "but that was out of the question." He did not have the standing to be admitted to Dr Smith, who had illustrious students in his care. Instead, Bentham was stuck with Mr Jefferson, whose ability to teach a course in natural philosophy Bentham doubted since "he has no apparatus" (Sprigge 1968, p. 60). He summarized his experience in the following manner:

> I learnt nothing. I played at tennis once or twice. I took to reading Greek of my own fancy; but there was no encouragement: we just went to the foolish lectures of our tutors, to be taught something of logical jargon. (Bentham and Bowring 1843, pp. 40–41)

Like Johnson, any improvement Bentham actually made as a student seems to have come from his own volition and his curious mind found little encouragement at Oxford.

Bentham's exclusion from Dr Smith's lessons shows how poorer students were barred from educational opportunities, not just social ones, as a result of the college hierarchy at Oxford. Disciplined individuals, who later became important intellectuals like Johnson, Bentham, and Dibdin, might be treated with relative indifference at Oxford because of their station. Blame cannot be put at the feet of a few particular colleges or the reigns of certain headmasters either: Johnson was at Pembroke College around 1730; Bentham took his Bachelor of Arts from Queen's College in 1763; and Dibdin was at St. John's College in the 1790s.

At least one eighteenth-century commentator recognized the problem. Among the loudest voices for reform at Oxford in the eighteenth century was Vicesimus Knox, a minister, writer, and headmaster of Tonbridge School in Kent. Formerly a Fellow of St. John's College, he called for an overhaul of the university curriculum in one of his best known works, *Liberal Education,* which went through at least eleven editions and many more printings. In the tenth edition, published in 1789, he attached a letter to Lord North, then Chancellor of the University, that condensed his reform recommendations to twenty short items. He argued in number five that "noblemen and gentlemen commoners should not be entitled to such exemptions from academical exercises, or salutary discipline, as tend to prevent or retard their improvement," and in number seven, that "the number of public tutors in every college should be increased in proportion to the number of undergraduates" (Knox 1789: viii-ix). Put together, these two reforms might have gone a long ways toward ensuring that eager students of meager means would have the same opportunities as their more affluent peers. As it was, however, the experiences of students like Toke, Bentham, Gibbon, and Johnson illustrate how intellectual development suffered across all ranks of students when the standards they were held to, and the quality of education they received, depended on the money they could pay, rather than their desire to learn.

References

Amhurst, Nicholas. 1726. "Terræ-Filius. No. IX". In *Terræ-Filius: Or, the secret history of the University of Oxford; In Several Essays,* ed. Amhurst, Nicholas. 45–51. London: R. Francklin.

Anonymous. 1756. *Memoirs of an Oxford scholar. Containing, his amour with the beautiful Miss L- of Essex; And interspers'd with several entertaining incidents*. London: W. Reeve.

Baker, Collins C. H. and Muriel I. Baker. 1949. *The life and circumstances of James Brydges, first duke of Chandos: Patron of the liberal arts*. London: Oxford University Press.

Bennett, G. V. 1986. "University, society and church 1688–1714". In *The history of the University of Oxford, Vol. 5: The eighteenth century,* ed. L. S. Sutherland and L. G. Mitchell, 359–400. Oxford: Oxford University Press.

Bentham, Jeremy and John Bowring. 1843. *The works of Jeremy Bentham, (Vol. X): Memoirs of Jeremy Bentham, including autobiographical conversations and correspondence*. Edinburgh: William Tait.

Bill, E. G. W. 1988. *Education at Christ Church Oxford, 1660–1800*. Oxford: Oxford University Press.

Boswell, James. 1791. *The life of Samuel Johnson, LL.D*. Vol. I. London: Henry Baldwin.

Cannon, John. 1984. *Aristocratic century: The peerage of eighteenth century England*. Cambridge: Cambridge University Press.

Dallimore, Arnold. 1970. *George Whitefield: The life and times of the great evangelist of the eighteenth century revival*. Vol. I. London: The Banner of Truth Trust.

Davenport, R. A. 1822. "The Life of Richard Jago". In *The British Poets, (Vol. 55): The poems of Gray and Jago*. Chiswick: C. Whittingham.

Dibdin, Thomas Frognall. 1836. *Reminiscences of a literary life*. London: John Major.

Ellis, Heather. 2012. *Generational conflict and university reform: Oxford in the age of revolution*. Leiden: Brill.

Evans, G. R. 2010. *The University of Oxford: A new history*. London: I. B. Tauris.

Gardiner, R. B. 1895. *The registers of Wadham College, Oxford: Part II, From 1719 to 1971*. London: George Bell and Sons.

Gibbon, Edward. 1796. *Miscellaneous works of Edward Gibbon, Esq. With memoirs of his life and writings, composed by himself.* Vol. I, ed. John Lord Sheffield. Dublin: P. Wogan et al.

Graves, Richard and William Seward. 1788. *Recollection of some particulars in the life of the Late William Shenstone, esq.* : *In a series of letters from an intimate friend of his to –- –-, esq. F. R. S*. London: J. Dodsley.

Green, V. H. H. 1986. "The university and social life". In *The history of the University of Oxford, (Vol. 5): The eighteenth century,* ed. L. S. Sutherland and L. G. Mitchell. 309–358. Oxford: Oxford University Press.
Harris, James, ed. 1844. *Diaries and correspondence of James Harris, first earl of Malmesbury*. Vol. I. London: Richard Bentley.
Hawkins, Sir John. 1787. *The life of Samuel Johnson, LL.D*. 2nd ed. (revised and corrected). London: Printed for J. Buckland et al.
Heberden, C. B., ed. 1909. *Brasenose college register. 1509–1909*. Vol. I. Oxford: Printed for the Oxford Historical Soceity at the Clarendon Press.
Innes, Cosmo. 1861. *Memoir of Andrew Dalzel, professor of greek in the University of Edinburgh*. Edinburgh: T. Constable.
Jenkins, D. E. 1908. *The life of the rev. Thomas Charles, B.A. of Bala: Promoter of charity & sunday schools, founder of the British and foreign bible society. Etc*. Vol. I. Denbigh: Llewelyn Jenkins.
Jones, John. 1988. *Balliol College: A history, 1263–1939*. Oxford: Oxford University Press.
Klein, Lawrence E. 2002."Politeness and the interpretation of the British Eighteenth Century". *The Historical Journal* 45 (4): 869–898.
Knox, Vicesimus. 1789. *A letter to the Right Hon. Lord North, chancellor of the University of Oxford; From Vicesimus Knox, M. A. late fellow of St. John's College, Oxford. Annexed to the tenth edition of Liberal education*. London: Charles Dilly.
Mallet, C. E. 1927. *A history of the University of Oxford: Vol. III, Modern Oxford*. London: Methuen & Co. Ltd.
Midgley, Graham. 1996. *University life in eighteenth-century Oxford*. New Haven: Yale University Press.
Minto, Countess of, ed. 1874. *Life and letters of Sir Gilbert Elliot First Earl of Minto from 1751 to 1806*. Vol. I. London: Longman, Green, and Co.
Mitchell, L. G. 1986. "Introduction". In *The history of the University of Oxford, Vol. 5: The eighteenth century*, ed. L. S. Sutherland and L. G. Mitchell, 1–8. Oxford: Oxford University Press.
Newman, John Henry. 1852. *Discourses on the scope and nature of university education, addressed to the catholics of Dublin*. Dublin: James Duffy.
Phillips, J. P. 1860. "College life at Oxford, one hundred and thirty years ago: Extracts from the diary of Erasmus Philipps". *Notes and Queries* series 2 X:365–366 & 443–445.
Radcliffe, Richard and John James. 1888. *Letters of Richard Radcliffe and John James of Queen's College, Oxford. 1755–83* ed. Margaret Evans. Oxford: Printed for the Oxford Historical Society at the Clarendon Press.
Rosenheim, James M. 1998. *The emergence of a ruling order: English landed society 1650–1750*. London: Longman.
Salmon, Thomas. 1744. *The present state of the universities and of the five adjacent counties, of Cambridge, Huntington, Bedford, Buckingham and Oxford*. Vol. I. London: J. Roberts.
Sprigge, Timothy L. S., ed. 1968. *The correspondence of Jeremy Bentham*. : *1752–1760*. Vol. I. London: The Athlone Press.
Sutherland, L. S. and L. G. Mitchell, eds. 1986. *The history of the University of Oxford: The eighteenth century*. Vol. 5. Oxford: Oxford University Press.
Thornton, Catherine and Frances McLaughlin. 1905. *The Fothergills of Ravenstonedale: their lives and their letters*. London: William Heineman.
Twiss, Horace. 1844. *The Public and Private Life of Lord Chancellor Eldon, with selections from his correspondence*. Vol. I. London: John Murray.
Whitefield, George. 1960. *George Whitefield's journals*. London: The Banner of Truth Trust.

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Chapter 3
From Ørsted to Bohr: The Sciences and the Danish University System, 1800–1920

Helge Kragh

3.1 University and Natural Philosophy until 1800

Throughout the entire period from the Renaissance to the mid-twentieth century, the University of Copenhagen stood unrivalled as Denmark's chief institution of science and learning. During this period the borders of the country changed several times, and it is important to be aware that for a long time Norway and Schleswig-Holstein were parts of the kingdom. Until 1658, southern Sweden also belonged to Denmark. The university that was established in Copenhagen in 1479 followed two years after a similar institution had been founded in Uppsala in Sweden, the first in Scandinavia. The new Danish-Catholic university was a small institution that did not (and was not meant to) lead to activities related to natural philosophy. In any case, it only lasted until the 1530s, when, as a result of the turmoil of the Reformation, this bastion of Catholic orthodoxy was replaced by a no less orthodox Evangelical-Lutheran university in 1536.

The explicit goal of the resurrected, now Lutheran university was to supply educated manpower to reinforce the State and the Church (Pinborg 1979). Nonetheless, subjects such as medicine, mathematics and natural philosophy were neither suppressed nor ignored. On the contrary, in the period from about 1570 to 1680 these subjects received much attention and were successfully cultivated in what is sometimes known as the "first golden age" of Danish science (Danneskiold-Samsøe 2004). The famous Tycho Brahe (1546–1601) gave lectures at the university in which he introduced Copernicus' new ideas, and in 1642 an astronomical observatory was completed atop the Round Tower in Copenhagen, being one of the first university observatories in the world (predated only by the observatory in Leiden). In this period Copenhagen could boast of a series of important professors in science and medicine, including the anatomist Thomas Bartholin (1616–1680), his brother, the physicist Erasmus Bartholin (1625–1698), the chemist Ole Borch

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(1626–1690), and the astronomer Ole Rømer (1644–1710) (Westfall 1994; Kragh et al. 2008). Although the geologist and anatomist Nicolaus Stenonis (Niels Stensen or Steno; 1638–1686) never became a professor in Copenhagen—his conversion to Catholicism excluded him—he did give lectures and public dissections at the *Domus Anatomicus* established in 1648 as part of the Faculty of Medicine.

While there was only one university in Denmark in the era of the scientific revolution, the larger and more powerful Sweden was a country with several universities (Jamison 1982; Danneskiold-Samsøe 2004). Apart from the original one in Uppsala, in 1668 a university was created in Lund in the southern part of the country. Later, universities were established also in Turku in Finland and in Tartu (or Dorpat) in Estonia, both countries being under Swedish rule. In addition, from 1648 to 1815 the university in Greifswald in northern Germany belonged to Sweden, at the time a major political and military power in Europe. In spite of the nearness of the two countries, and the similarity in language and culture, until the early nineteenth century there was very little direct contact between academics in Sweden and Denmark.

Starting at the end of the seventeenth century, a period of decline set in that was further aggravated by a great fire in 1728, which destroyed much of Copenhagen and its university. By that time science in Denmark was all but non-existent. Although physics, mathematics and medicine were represented at the university, it was in a form that can best be described as petrified and to which research was virtually unknown. The general attitude of the Crown and the civil administration was one of indifference. The earliest initiative showing a renewed interest in the sciences was the establishment in 1742 of the Royal Danish Academy of Sciences and Letters, an institution that soon became very influential and left its mark on the development of science in Denmark until well into the twentieth century (Pedersen 1992). Although an independent institution, in reality it was closely associated with the university. Most of the members were university professors or otherwise affiliated with the university, and many of them were in the fields of the medical, mathematical and natural sciences. Yet another institution that signaled a renewed interest in the sciences was the Sorø Academy, some 60 km from Copenhagen, where for a period young noblemen were taught mathematics and physics at a high level. Jens Kraft (1720–1765), a physicist and professor at Sorø, was a distinguished member of the Royal Academy.

During the 1700s the population of Denmark grew at a steady pace, increasing from about 600,000 in 1700 to nearly 800,000 in 1770 (Johansen 2002). The growth continued over subsequent decades, and in 1850 the country had a population of 1.42 million, to which should be added the citizens in Norway and the duchies of Schleswig-Holstein. On the other hand, the population growth did not result in a corresponding growth in the number of university students. During the 110 years from 1740 to 1850 the number of students matriculated at the University of Copenhagen fluctuated between 110 and 210 students per decade, the vast majority of them training for positions as priests or bureaucrats in the state administration. In short, the university was primarily a school for educating clerics, and secondarily a school for training lawyers and judges. Of the 8,176 graduates leaving the university between the two university reforms of 1732 and 1788, 66.7% graduated in theology and 30.6 % in law, whereas only 1.5 % graduated in philology and 1.2 % in medicine (Kragh et al. 2008, p. 138). It was not yet possible to graduate with a university degree in any of the natural sciences, which belonged to either the philosophical or the medical faculty. Given the paucity of qualified Danes, scientists were often called upon from abroad, especially from Germany. For example, this was the case with Christian Gottlieb Kratzenstein (1723–1795), who in 1753 was appointed extraordinary professor in experimental physics and later served as professor of medicine (Snorrason 1974; Splinter 2007).

Despite the efforts of Kratzenstein and a few other professors, Danish science was not thriving in the latter half of the eighteenth century. To the modest extent it was cultivated in Denmark, science rarely moved beyond serving as an ancillary subject at the university. Although not unknown, systematic basic research founded on quantitative experiments and mathematically formulated theories had not yet caught on in the kingdom. There was often dissatisfaction with the quality of Danish scholarship and science, not least in comparison with foreign standards. As the university patron Count Johan Ludvig Holstein (1694–1769) pointed out in 1754, the professors in Copenhagen only rarely presented scientific treatises that earned international attention. 40 years later the situation had improved, but not substantially. Part of the problem was that professional qualifications were not always considered a key criterion for appointing tenured professors, neither in practice nor according to the university charter of 1732. This unfortunate practice was not halted until the charter was amended in 1788, the new rule being that available professorships had to be publicly announced and awarded to the applicant deemed best qualified. This was a necessary but not sufficient measure to ensure vitality in the sciences covered by the university.

3.2 Troubles and Progress in the Romantic Era

Even with the reform of 1788, the scientific fields were vulnerable and their positions within the university system weak. By 1805, the four faculties of the university—philosophy, law, theology and medicine—comprised thirty full professors of which only four were teaching mathematics and natural science, all of them within the philosophical faculty. Physics and chemistry, as well as botany, were still auxiliary disciplines within the Faculty of Medicine. The following year the first two subjects were transferred to the philosophical faculty, and in 1817 the change was extended to botany as well. However, the emancipation from medicine was not necessarily an advantage. A main problem was that the sciences were but a small part of the very large and heterogeneous Faculty of Philosophy, and also that the experimental sciences were not represented in the governing body of the university, the Senate. Among the scientists, only the ordinary professors of mathematics and astronomy had the right of representation in the Senate. The different reputations of the sciences are further illustrated by the prize system for students that the university, copying the system from Göttingen, had established in 1791. The prize system was restricted to mathematics and astronomy among the sciences, and it took until 1826 before physics and chemistry were granted the right of awarding prizes.

In 1806, 29-year-old Hans Christian Ørsted was appointed extraordinary professor of physics, a position which in 1817 was transformed into an ordinary professorship. In addition to his important scientific work, Ørsted also worked hard to improve the conditions of science in Denmark, both at the university and elsewhere. Thus, having returned from a study tour to Prussia and France, in 1813 he proposed to the minister of finance a reform of the scientific studies along the lines he had experienced in France. Impressed by the close connections between theory and application in the French system of higher education, he suggested a similar connection to be part of the university's teaching of physics and chemistry. Moreover, he wanted a drastic change in the faculty structure, namely a division of the philosophical faculty into two separate faculties, the one covering the humanistic studies and the other the mathematical and physical sciences. However, nothing came of Ørsted's proposal, primarily because it was unfortunately timed: as a result of the Napoleonic wars, in 1813 the Danish state went bankrupt. The government had more serious matters to worry about than the role of the sciences within the university system. A separate science faculty had to wait for another 37 years.

In spite of the country's economic and political troubles, the status of the sciences did improve, if only slowly and generally without the consent of the conservative university. A number of new chairs were established, most of them provisional and funded by the State rather than the university itself. For example, in 1821 the young botanist and geographer Joakim Frederik Schouw (1789–1852), a pioneer of plant geography (Nicolson 1996), was appointed extraordinary professor of botany within the medical faculty. The following year the chemist William Zeise (1789–1847), a pupil of Ørsted, was appointed extraordinary professor of chemistry, the first Danish university chair of its kind. Both chairs were subsequently transformed into ordinary professorships. Also geology won recognition, and again for the first time, namely when a new professorship in mineralogy and geology was created in 1831 for Johan Georg Forchhammer (1794–1865). Although trained in chemistry and pharmacy, and without a formal education in geology, he became Denmark's first full professor in the field.

The strengthened position of the sciences only meant that it became even more intolerable to be relegated to what was in effect a foreign faculty, the Faculty of Philosophy, in which the interests of the scientists were given low priority. It became clear that the university's politics were untenable when in 1815 Heinrich Christian Schumacher (1780–1850) was appointed professor of astronomy, thereby gaining access to the Senate, while Ørsted, who at the time had been professor of physics for nine years, was still barred from entering. In short, the university's Charter was unable to accommodate the new subjects that were branching off the academic tree of learning. It became increasingly unacceptable that a growing group of the university's professors were cut off from many of the privileges accompanying membership of the Senate, such as rent-free accommodation and potential allocation of university grants. A solution would have to be found.

It was on this background that Ørsted thought of establishing a kind of substitution for a science faculty, but in the form of a scientific-technical school that was not formally a part the university. A somewhat similar idea had been aired before, although then the planned institution was conceived as a school for artisans and craftsmen modelled after the German *Gewerbeschulen* (Wagner 1993; König 1993). While the earlier plan was based on the technical colleges in Prussia and elsewhere in the German States, Ørsted's was inspired more by the École Polytechnique in France. His proposal was much more scientifically oriented, offering little or no training in practical craftsmanship skills. Ørsted envisioned his new construction as being closely linked with the university, and as a way of creating scientific-technical graduate competences outside the university, but still associated with it. As he phrased it in a report of 1828, he wanted "a higher educational institution in close connection with the university," which, he claimed, "would obviously be far more beneficial to the State" (Wagner 1993, p. 154).

Ørsted's proposal met with royal approval, and in November 1829 the Polytechnical College—which today is the Technical University of Denmark—was officially inaugurated in the presence of the king, Frederik VI. The close links to the university were ensured not only by teachers serving on both staffs, but also by the new institution taking over some of the university's buildings in Copenhagen. The initial staff consisted of seven people, four of whom were associated with the university as either professors or lecturers. Ørsted himself taught physics and also served as director of the new technical college, retaining that position until his death in 1851. The courses in chemistry and applied natural science were given by Zeise and Forchhammer. Although Ørsted had been greatly inspired by the École Polytechnique, the new college of advanced technology in Copenhagen was by no means a school of engineering during its early years. Later, from 1861 onwards, the college did develop to educate civil engineers, but under Ørsted's leadership it was foreign to engineering subjects, being an academic institution whose purpose was to school technological graduates.

Ørsted's brainchild soon had a positive impact on Danish science, amongst other reasons because it admitted talented students without a high-school exam. Among the earliest polytechnical candidates was Ludvig August Colding (1815–1888), who counts as one of the co-discoverers of the principle of energy conservation (Caneva 1997; Kragh 2009). On the other hand, scientifically valuable as the Polytechnical College was, for a while it did not stimulate the country's industrial development to the extent that its creators had intended.

Still in the mid-nineteenth century the university courses and degrees in science had not been fully institutionalized—a process that did not take place until the Faculty of Science was established in 1850. As early as 1848, however, students could earn a master's degree in natural history. Before that time it was not possible to take an actual scientific degree in the field in which one specialized at the university. Although the establishment of the Polytechnical College in 1829 remedied this situation somewhat, the existence of the new college also unintentionally impeded the development of scientific subjects at the University of Copenhagen.

3.3 Universities and Wars

Denmark's unfortunate intervention in the Napoleonic wars had serious consequences for its science and culture. In 1807 the British navy bombarded Copenhagen, causing severe damage and the destruction of many buildings, books and instruments belonging to the university. Nonetheless, the king and his government kept to the alliance with France and even sought to expand the country's university system. There had for some time been a strong wish among the Norwegians to have their own university, and under the difficult political circumstances the king found it opportune to grant them the right. In the fall of 1811 the Royal Frederiks University (today's University of Oslo) was established in the city of Christiania, or what since 1925 was renamed Oslo, the capital of Norway. The new Norwegian university remained under Danish rule, administrated from Copenhagen, but only for a few short years; in 1814 Denmark lost Norway to the Swedish crown (Norway became fully independent only in 1905).

The structure of the Royal Frederiks University was traditional and copied from the one in Copenhagen. It consisted of four faculties (theology, law, medicine and philosophy), with the science subjects placed under the Faculty of Philosophy. The early years of the Norwegian-Danish university were marked by hardships, the country being at war with England and therefore desperately short of funds. It was not until 1813 that the first professors were appointed and construction work begun, including buildings for science and medicine. From a scientific point of view, the most important of the professors was the astronomer and physicist Christopher Hansteen (1784–1873), who specialized in geomagnetism and was a good friend of Ørsted. The close contact between these two men was one factor that sustained the bond between the universities in Copenhagen and Oslo throughout the split in 1814 and beyond.

Another factor that bound together the universities of the three Nordic countries during the nineteenth century was the 'Scandinavism' that emerged as a strong political and cultural ideology a few decades later. The basis of this ideology was a growing recognition that the people in the three countries had much more in common than what separated them. They were, so it was held, merely three different tribes of the same nation. Inspired by the German meetings of scientists and physicians that since 1822 had taken place under the aegis of the Gesellschaft deutscher Naturforscher und Ärzte, leading Scandinavian scientists established a similar organization that first convened in Gothenburg in Sweden in 1839 and the following year in Copenhagen. The series of meetings that followed became highly successful and helped establish strong ties between scientists and universities from the three countries (Kragh et al. 2008, pp. 180–181). For example, at the fifth meeting in Copenhagen in 1847, the number of participants had grown to 472, including local celebrities such as Jöns Jacob Berzelius (1779–1848) from Sweden, H. C. Ørsted from Denmark, and C. Hansteen from Norway. For several years the Scandinavian meetings were important for the exchange of scientific knowledge, although from about 1870 they degenerated into formal gatherings with little scientific substance.

Generally, in the period from about 1840 to 1920 there was a fruitful collaboration between scientists from the Scandinavian universities.

For a brief period of time, between 1811 and 1814, the Danish kingdom could pride itself on having no less than three universities. Between 1773 and 1864 the university in Kiel was under Danish administration, although in practical terms it remained German in many ways and was regarded by Copenhagen as something of a foreign body embedded in the realm (Schmidt-Schönbeck 1965). The institution was mainly important to the still-Danish region of Schleswig-Holstein, whereas its significance to science in Denmark was limited. There was one noteworthy scientist there, however: the professor Christoph Heinrich Pfaff (1773–1852), who took up his chair in 1798 and remained a leading figure in German and Danish science until his death in 1852. It was Pfaff who made sure, in 1802, that the university in Kiel was equipped with a modern physics and chemistry laboratory, which became the primary location of Pfaff's own important investigations into galvanic electricity (Kragh 2003). The Danish physician Peter Ludvig Panum (1820–1885), who worked as a professor in Kiel between 1853 and 1864, later established a modern laboratory for physiological chemistry.

In spite of its limited significance to Danish science, the university in Kiel was indirectly of some importance; for periods it served as an institution where young Danish scientists could stay until they obtained a position in Copenhagen. Thus, as a young man Forchhammer stayed with Pfaff in Kiel, where he wrote his doctoral dissertation. After having become a professor in Copenhagen, Panum repeated what he had done in Kiel, namely, setting up the university's first modern laboratory for biological research.

A local movement known as 'Schleswig-Holsteinism', springing from the German movement for unity and freedom arose around 1815. Its goal was independence. This new movement quickly became entrenched at the university in Kiel, which would be at the centre of the region's pro-German and Prussian-supported rebellion in 1848, leading to the so-called 'three-years war' that eventually was won by the Danes. The connection between the university and the German nationalist sentiments had dire consequences; the administration in Copenhagen lost interest in the disloyal university, which therefore ceased to develop. The University of Copenhagen was favoured financially, whereas the north German city of Kiel faced a bleak academic future. In 1852, after having quelled the rebellion, the Danish government fired one-third of the professors there, additionally causing the number of students to plummet. Twelve years later the University of Kiel became German, a result of the Danish defeat to the Prussian and Austrian forces in the disastrous war of 1864. Now Denmark had but a single university, a situation that would continue until 1928, when Aarhus University was inaugurated, to be officially recognized five years later.

The civil war in Schleswig-Holstein also had serious consequences for Danish astronomy, which at the time had its centre in Altona near Hamburg rather than in Copenhagen. The professor of astronomy, the Holsteinian H. C. Schumacher, had in the early 1820s set up a new observatory there, funded by the Crown, in this outskirt of the Danish kingdom. In Altona, he published the important journal

Astronomische Nachrichten, and became a central figure in the international astronomy community. Loyal to the Danish king, Schumacher initially declined to join the rebel cause but was eventually forced to do so in order to get fresh funds to his impoverished observatory. The turn of events took a heavy toll on the aged astronomer, who died in 1850, shortly after the rebellion failed.

Foreign scientific relations assumed a new importance around the turn of the First World War, during which Denmark succeeded in preserving its neutrality despite its precarious geographical position at the entrance to the Baltic Sea. While science in the belligerent countries suffered during the war (Agar 2012, pp. 89–117), this was not the case in Denmark. On the contrary, many scientists benefitted from being able to maintain contacts with German, French and English colleagues. For example, although Niels Bohr worked in Cambridge during part of the war, he also stayed in contact with the strong groups of physicists in Germany and had easy access to their publications. When the International Research Council was formed in 1919, at first membership was restricted to the Allied powers and associated nations, and it took until 1922 before some of the neutral countries, including those in Scandinavia, were admitted (Crawford 1992). German science was boycotted, but scientists in Denmark and the other Scandinavian countries resisted the boycott and violated it on several occasions.

3.4 A Network of Science Institutions

In the period from 1864 to 1920, the University of Copenhagen was Denmark's only university, but far from the country's only institution for scientific activity. On the contrary, the period witnessed a proliferation of new institutions, many of which were devoted to the kind of applied science and technology that was not covered by the traditional and still rather conservative university. After all, this was the era of industrialization that required forms of expertise the university could rarely provide.

During the same span of years the institutes under the Faculty of Science expanded with the establishment of several new laboratories and similar sites for teaching and research. After much discussion, a large botanical garden with an affiliated botanical laboratory belonging to the university became a reality in 1874, placed in the quarter of Copenhagen called Østervold. At about the same time several university museums were established, including a zoological museum and a mineralogical museum. The botanical garden bordered with another major science investment, a new astronomical observatory. It had been realized for quite some time that the old and venerable observatory at the Round Tower, going back to the mid-seventeenth century, was no longer suited for precise astronomical observations and consequently that a new observatory was needed. It was in part for this purpose that the German astronomer Heinrich Louis d'Arrest (1822–1875) was appointed professor of astronomy in 1857. The following year the parliament—Denmark had become a democracy just a few years earlier—granted the substantial sum of 91,000 Danish kroner to move the observatory and provide it with modern instruments of the best possible quality. To get an impression of this significant amount of money, it may be compared with the annual budget of the University of Copenhagen, which at the time was about 200,000 kroner. The new observatory was ready in 1861 and it remained in use until the 1950s, although by that time it was outdated and useless for scientific purposes.

Nineteenth-century Denmark had only one significant scientific and cultural centre, the capital. The infrastructure of Danish science was tight and almost exclusively limited to Copenhagen, still a small city where most of the leading scientists had personal connections. Although most of the new institutions had no formal connections with the university, in reality the network relied heavily on the few but powerful university professors and their academic associates.

The increasing number of scientific institutions and societies made Copenhagen an attractive scientific city, not only in a Scandinavian context but also internationally. In an age of science, this was an argument that weighed heavily among the industrialists and politicians who were supposed to donate money for the noble cause. The international archaeology conference that convened in Copenhagen in 1869 enjoyed high-level coverage and bolstered Denmark's scientific pride. The same was the case, and to an even higher degree, with the Eight International Medical Conference held in the Danish capital in 1884. At this event Danish physicians and scientists could listen to the reports of Joseph Lister (1827–1912) and Louis Pasteur (1822–1895), at the time two of the superstars of international science.

Of course, most of the important scientific congresses and meetings took place abroad, often with participation of Danish scientists. For example, the first and only International Congress of Physics convened in Paris in 1900 in connection with the World Exhibition that year. The three-volume proceedings of the congress included seventy scientific review articles written by leading physicists from fifteen countries (Guillaume 1900). Two of them were Danes, and there were also contributions from two Swedes and two Norwegians. The physics professor Christian Christiansen (1843–1917) wrote on contact electricity, and Adam Paulsen (1833–1907), the director of the Meteorological Institute founded in 1872, wrote on the aurora borealis. As the example indicates, Danish scientists were at the time part of the international science community, if only on a relatively modest level.

The Polytechnical College continued being the most important of the non-university institutions and the one with the closest connections to the University of Copenhagen. The tradition from the Ørsted era, that the technical school and the university shared teachers, continued throughout the period and was particularly strong in physics, chemistry and mathematics. To mention but one example, consider the career of the eminent chemist Julius Thomsen (1826–1909), who won international acclaim for his contributions in thermochemistry. A graduate of the Polytechnical College, from 1859–1866 he taught physics at the Royal Danish Military Academy founded in 1829. He was then appointed ordinary professor of chemistry at the university and, at the same time, manager of the chemical laboratory at the Polytechnical College. Thomsen remained a university professor until 1901, and in the years 1893–1902 he also served as director of the Polytechnical College. To him, there was little difference between the two sister institutions.

The Royal Veterinary and Agricultural College that was established in 1858 developed into an institution of nearly the same scientific significance as the Polytechnical College. In 1882 it was supplemented by an agricultural research laboratory, beginning very modestly with a small staff but soon expanding to include departments for chemistry, bacteriology and animal physiology. By the early years of the new century the Agricultural College had become a large and important research institution with, as usual, strong ties to the university. Although focusing on subjects of relevance to Danish agriculture, the college also included basic research within the chemical and biological sciences. It is telling that Denmark's most promising chemist at the time, Niels Bjerrum (1879–1958), in 1912 became professor at the Agricultural College. Internationally known for his pioneering work in molecular spectroscopy, Bjerrum successfully established an active research environment for chemistry at the Agricultural College, attracting international interest as well as foreign visitors (Kauffman 1980). His appointment greatly enhanced the status of chemistry at the Agricultural College, and also raised the college's standing in the Danish chemistry community.

While the institutions mentioned so far were all public and run by the State, there were also some noteworthy examples of private initiatives. This was the case with the Pharmaceutical College created in 1892 on the basis of funds provided by Christian Hansen (1843–1916), a wealthy pharmacist who in his youth had worked as an assistant of Julius Thomsen at the university's chemical laboratory. Whereas Hansen established the new pharmaceutical school, it was on the condition that its operation was managed by the State, which has been the case ever since. More scientifically important than the Pharmaceutical College was the Carlsberg Laboratory established in 1876 by the rich brewer and philanthropist Jacob Christian Jacobsen (1811–1887), the founder of the Carlsberg Breweries (Holter and Møller 1976). The financial background for the laboratory was a generous grant from the Carlsberg Foundation, which Jacobsen decided should be managed by the Royal Academy of Sciences. Although the emphasis was on subjects related to the fermentation industry in a broad sense, the new laboratory was (and still is) an institution for basic research. The laboratory was split into two departments, one for chemistry and one for physiology, and from their very beginnings both departments became major players in the Danish scientific landscape. Several of the most eminent laboratory scientists in the decades around 1900 carried out research at the two laboratories, among them the naturalists Emil Christian Hansen (1842–1909) and Wilhelm Johannsen (1857–1927) and the chemists Johan Kjeldahl (1849–1900) and Søren P. L. Sørensen (1868–1939), the latter of pH fame.

Although Copenhagen completely dominated the Danish scientific landscape in the early years of the twentieth century, there were at the time proposals for a medical school in Aarhus, possibly as the beginning of a university-like institution. The proposals led to much discussion, but failed to enjoy support in Copenhagen. The university professors found it unnecessary as well as unwise to create a second university in small Denmark, and the Ministry of Education had no money for it. The plan was scarcely taken seriously. Only in 1928 did the fight for a university in Jutland move ahead, with the result that Aarhus University was established by law in 1933. A science faculty followed in 1954.

3.5 The Copenhagen Science Faculty

The battle over university politics mentioned in Section 2, and the attempts to create a new institutional framework for the scientific fields, came to a culmination in the late 1840s. Finally the internal pressure became too great to ignore and at last, in 1850, a decision was made to split the Faculty of Philosophy into two, thereby creating an independent Faculty of Science, or a mathematical-scientific faculty. At its establishment it consisted of seven full professorial chairs, represented by H. C. Ørsted (physics), J. F. Schouw (botany), C. Ramus (1806–1856; mathematics), E. Scharling (1807–1866; chemistry), J. G. Forchhammer (mineralogy/geology), J. Steenstrup (1813–1897; zoology), and C. Olufsen (1802–1855; astronomy). By 1920 the faculty had doubled in size, now comprising seventeen full chairs including two in each of mathematics, physics, chemistry and botany. With the innovation of 1850, the university was equipped with a strong scientific foundation on which to build a framework capable of handling the changes and challenges to come. These challenges included field differentiation and increased specialization, as well as new and growing demands to scientific research and to the education of science graduates.

The creation of an independent faculty was a victory for the sciences, which now at last were granted the same status and rights as other academic fields. Compared with the situation elsewhere in Europe, the science faculty in Copenhagen came early, and it was the first such faculty in Scandinavia, to be followed by the university in Oslo ten years later. Science faculties were organized at most German universities only in the twentieth century, and at some major European universities independent faculties of science became a reality only after the Second World War. Examples are the Swedish universities in Lund and Uppsala (both in 1956) and the University of Kiel in 1963. However, new faculty structures do not necessarily signify a changed relationship in the importance of the various academic fields. Certainly, in the cases of Copenhagen and Oslo the early dates did not reflect a corresponding strength of the sciences.

Although the science faculty grew in size and importance during the second half of the nineteenth century, in some respects Danish science remained somewhat provincial and even backwards. It was a weakness of the system that, for most of the sciences, there was only a single professor whose ideas, whether progressive or conservative, would dominate teaching and research in the field. In some sciences, tradition counted more than innovation, such as was the case in physics for several decades after Ørsted's death in 1851. To Ørsted, the experiment was the central element of physics, indeed the only one worth paying attention to, whereas he failed to appreciate the mathematical direction that physics was taking internationally (Pedersen 1988). Likewise, as a generalist of romantic inclination, he addressed his science as much or more to a local Danish audience as to the international community of physics.

There is little doubt that the heritage of Ørsted had a detrimental effect on Danish physics, both at the university and at the Polytechnical College. His successor, Carl Holten (1818–1886), was foreign to the new theoretical physics and preferred to retain the ørstedian tradition with its emphasis on experiment and popularization.

Characteristically, his textbook in mechanics of 1881 did not make use of calculus and it ignored Newton's laws of motion. Holten held his professorship for 34 years, and it was not until 1886, when Christian Christiansen took over Holten's chair, that a much needed change occurred. Only then did Danish physics finally manage to overcome Ørsted's pervasive legacy. Christiansen's textbook in physics, translated into German in 1894 as *Elemente der theoretischen Physik*, was thoroughly modern. Written in the great tradition of Kirchhoff and Helmholtz, it was remarkable for its inclusion of the most recent international research (Christiansen 1894).

Until the 1870s, the University of Copenhagen was an all-male school. Women did not have the right to demand admission, although, on the other hand, there was nothing in the charter of the university that prevented such admission. The question first came up in 1874, when 25-year-old Nielsine Nielsen (1865–1931) requested to be admitted to the university to study medicine. After the application had been evaluated, first by the Faculty of Law and then by the Faculty of Medicine, she was granted the right. In 1875 the king, Christian IX, signed an ordnance stating that "female students matriculated at the university shall have the same access as the other students to pursue the study of subjects selected by them, and to present themselves for the standard examinations and academic degrees arranged by the university" (Kragh et al. 2008, p. 279).

During the last two decades of the century, a small number of women began studies in the Faculty of Science, although for a long time they remained a tiny minority. On the other hand, there was no widespread opposition among the professors and the courses at the faculty were no different for female students than for male. The first woman to obtain a science degree from the University of Copenhagen was Sofie Rostrup (1857–1940), who in 1889 defended her master's thesis on the interaction between plants and insects.

It took another twenty years until a woman earned a science doctorate. Kirstine Meyer (1861–1934) had achieved her master's degree in physics in 1892 and subsequently worked as a school teacher and educational consultant. Her dissertation was a historical study on the development of the concept of temperature through the ages; in her later career she also contributed to aspects of the history of science. For example, in 1920 she edited and published three valuable volumes on Ørsted's scientific writings. Moreover, she played an important role in the small Danish physics community, wrote elementary physics textbooks, and in 1902 she founded *Fysisk Tidsskrift*, the journal of the Danish Physical Society. Also worth noticing is that Meyer was the first woman to receive one of the prestigious gold medals of the Royal Danish Academy of Sciences, which she did in 1899. Neither Rostrup, Meyer, or any other Danish women succeeded in obtaining a university position in the period here dealt with. In fact, this only became possible with a law of 1921. It took until 1958 before the first woman scientist—Bodil Jerslev (1919–2005), an organic chemist—was appointed professor, and then it was at the Pharmaceutical College. Only in 1966 (!) did the science faculty of the University of Copenhagen get its first female professor, the geologist Tove Birkelund (1928–1986).

3.6 Some Highlights

In spite of its smallness, Danish university-based science was by 1920 in a relatively healthy situation and rapidly on its way towards integration in the international science system. In some of the fields a much needed generational change occurred around 1910, when the older professors retired and were replaced by a new generation of more innovative and modern-thinking scientists. This was the case in mathematics, where Julius Petersen (1865–1931) and Hieronymus G. Zeuthen (1839–1920) initiated a modernization of mathematical research and teaching, and also in chemistry, where Bjerrum and Johannes Brønsted (1879–1947) introduced the methods of physical chemistry and turned Copenhagen into an important chemical city.

One measure of the increased international recognition of Danish scientists—meaning scientists in Copenhagen—is the number nominated for the prestigious Nobel Prize, which was first awarded in 1901. In the two decades thereafter twelve Danish scientists were nominated, most of them with professorial positions at or associated with the University of Copenhagen (Nielsen and Nielsen 2001): four in physics, two in chemistry, and six in physiology or medicine. Of these nominees, four actually received the prize, namely, Niels Finsen (1860–1904; physiology: 1903), August Krogh (1874–1949; physiology: 1920), Niels Bohr (physics: 1922), and Johannes Fibiger (1867–1928; physiology: 1926). While Krogh and Bohr were professors in the science faculty, Fibiger was professor in the medical faculty and also Finsen, who died the year after he became a Nobel laureate, was employed by the medical faculty.

Yet another indicator of international recognition is membership of prestigious foreign academies of science, of which the Royal Society in London is possibly the most distinguished. From the beginning of the nineteenth century to the 1920s, six Danish scientists became elected as foreign members of the Royal Society, two astronomers (H. C. Schumacher: 1821; P. A. Hansen: 1835), two physicists (H. C. Ørsted: 1821; N. Bohr: 1926), one chemist (J. Thomsen: 1902), and one zoologist (J. Steenstrup: 1863). Apart from Hansen (1795–1874), most of whose career took place in Germany, they all served as professors at the University of Copenhagen.

The slow but steady progress that marked the two first decades of the twentieth century was not a result of any strong wish to support the sciences or any visionary politics from either the governing body of the university or the Ministry of Education. Rather the contrary, for the Ministry was generally reluctant to spend large sums of money on the sciences. Having no intention to be involved in research, it did not appreciate that most fields of science and medicine were undergoing rapid development in the early years of the new century. It was an uphill battle to create new laboratories and institutions, but sometimes the battles were won, such as was the case with what today is named the Niels Bohr Institute (Robertson 1979).

When 30-year-old Niels Bohr was appointed to a new professorship in 1916, all the space he was given was a small room (of about 15 square metres) at the

Polytechnical College, which he had to share with his assistant, the Dutchman Hendrik Kramers (1894–1952). In the same year the Polytechnical College had been allowed to grant its own doctoral degrees, which placed it on nearly the same footing as the university and loosened the union between the two institutions that had gone back to the time of Ørsted. Under these circumstances Bohr proposed that the university should establish its own institution for theoretical physics. The road to the goal turned out to be long and difficult, principally because of the reservations and economic constraints of the Ministry of Education. Yet, in the end the State agreed to pay for most of the planned institute, but only after a private committee had collected a substantial amount of money and the Carlsberg Foundation and other private sponsors had provided generous grants for the necessary equipment and instruments. The University Institute of Theoretical Physics, or what unofficially became known as Bohr's institute, was finally inaugurated on 3 March 1921. Its significance for the development of international as well as Danish physics hardly needs to be emphasized (Kragh 2012). Only in 1965, three years after Bohr's death, did it officially change its name to the Niels Bohr Institute.

3.7 Between Internationalism and Provincialism

A small country with its own language invariably faces the problem that its science and higher education must be oriented both toward a local and an international audience. Although science is international, it also has a national orientation and responsibility both on the level of research and education. In the case of Denmark, it had for a long time been a tradition that the professors wrote their own textbooks for the students and, since the late eighteenth century, that these were written in Danish (rather than in Latin). Until well into the twentieth century there are no examples of use of university textbooks in foreign languages, neither in German, French, English, nor in Swedish. This tradition, which only came to an end in the 1960s, did not further an international outlook.

Danish scientists in the nineteenth century typically published their research in both Danish and a foreign language, which in most cases would be German but could also be French or, much less commonly, English. The publication pattern differed somewhat from one science to another, but generally with a drastic change towards foreign-language, international journals since the 1860s. By that time, indifference to an international audience was a luxury that the new generation of scientists could ill afford. While Ørsted published more works in Danish than in German—and communicated his most important work, the discovery of electromagnetism, in Latin—the later generations of physicists and chemists were careful to publish most of their research papers in German and other foreign languages (Kragh 1998, p. 252).

Julius Thomsen, a prolific writer, published no less than 149 papers in German in the period between 1852 and 1905, of which several were translations of papers simultaneously appearing in Danish journals. On a less impressive scale, other chemists followed the pattern. Foreign journals did not necessarily mean publication in foreign journals, but sometimes took place through local journals of international scope, such as the *Proceedings of the Royal Academy* and the *Comptes Rendus des Travaux du Laboratoire Carlsberg* founded in 1878. The latter journal, which specialized in biochemistry and physiological chemistry, contained articles in Danish, English, German and French, but from the 1920s onward French was largely replaced by English. The shift is exemplified by S. P. L. Sørensen's publications in that journal: from 1906 to 1915, all of his seventeen publications were in French; between 1916 and 1933, twelve were in English and only two in French. Sørensen also published widely in German journals. In general, although English became increasingly important in the 1920s, German remained the dominant scientific language until the late 1930s.

Yet another example is provided by August Krogh, who from 1901 to 1909 had 33 research publications, fifteen of which were in Danish, ten in German and eight in English. From 1910 to 1919 he turned out 59 research publications: 39 in English, seven in German, and thirteen in Danish. After 1920, the year in which he received his Nobel Prize, Krogh published predominantly in English, with only a small number still in German, French and Danish.

The *Proceedings* of the Royal Danish Academy of Sciences was an important publication for the elite scientists that were members of the Academy. However, since its establishment in 1745 its language had been Danish, a policy it took a long time to change. Ørsted saw no reasons for a change. On the contrary, during his 36-year-long presidency he actively resisted attempts to modernize and thus, according to one historian, "made the Society pay the heavy cost of being linguistically isolated in the learned community as a whole" (Pedersen 1992, p. 173). Only in 1902 did the Academy agree to publish in other languages than Danish and thus to make its publications accessible to readers outside Scandinavia.

The change occurred late, but after all earlier than a corresponding change in the venerable system of doctoral dissertations at the University of Copenhagen. According to the rules of the university, a dissertation had to be written either in Danish, Swedish or Latin. It took until 1921 before it was allowed to write a doctoral dissertation in one of the European main languages, French, German or English. Among the victims of this archaic rule was young Niels Bohr, who in 1911 defended his dissertation on the electron theory of metals before the Faculty of Science. The thesis was a comprehensive and innovative analysis that revealed, more clearly than before, the failure of classical physics and the necessity of introducing concepts of quantum theory. Yet, in spite of the innovative nature of his work it remained unknown outside Denmark, for the simple reason that physicists could not understand its language. Bohr subsequently fought hard to have it translated into English, but his efforts bore no fruit (Kragh 2012). When an English translation finally appeared, a decade after Bohr's death, it was of historical interest only.

The slow but steady growth that had characterized Danish science in the early part of the twentieth century continued during the interwar period in spite of a weak national economy that did not allow major research investments. The growth was to a considerable extent indebted to private foundations, some of which were national, such as the Carlsberg Foundation and the Rask-Ørsted Foundation. However, far the most important of the philanthropic organizations was the International Education Board, a branch of the Rockefeller Foundation (Kohler 1991). The importance of Rockefeller money for Danish science in the 1920s and 1930s can hardly be overestimated. It was primarily thanks to generous grants from the International Education Board that new research institutions and university buildings became possible, such as extensions to Bohr's institute, the Institute for Physical Chemistry, and the Rockefeller Institute, a large complex of university institutions for the medical and biochemical sciences. Massive public grants for scientific research, not to mention a national research and university policy, still belonged to the future.

References

Agar, Jon. 2012. *Science in the twentieth century and beyond*. Cambridge: Polity Press.

Caneva, Kenneth L. 1997. Colding, Ørsted, and the meaning of force. *Historical Studies in the Physical and Biological Sciences* 28:1–138.

Christiansen, Christian. 1894. *Elemente der theoretischen Physik*. Leipzig: Ambrosius Barth.

Crawford, Elisabeth. 1992. *Nationalism and internationalism in science 1880–1939*. Cambridge: Cambridge University Press.

Danneskiold-Samsøe, Jakob. 2004. *Muses and patrons: Cultures of national philosophy in seventeenth-century Scandinavia*. Lund: Lund University.

Guillaume, Ch.-Éd., ed. 1900. *Rapports Présentés au Congrès International de Physique*. Paris: Gauthier-Villars.

Holter, Heinz, and Knud Max Møller. 1976. *The Carlsberg Laboratory 1876–1976*. Copenhagen: Rhodos.

Jamison, Andrew. 1982. *National components of scientific knowledge: A contribution to the social theory of science*. Lund: Research Policy Institute.

Johansen, Hans Christian. 2002. *Danish population history 1600–1939*. Odense: University Press of Southern Denmark.

Kauffman, George B. 1980. Niels Bjerrum (1879–1958): A centennial evaluation. *Journal of Chemical Education* 57: 779–782.

Kohler, Robert E. 1991. *Partners in science: Foundations and the natural scientists, 1900–1950*. Chicago: University of Chicago Press.

König, Wolfgang. 1993. Technical education and industrial performance in Germany: A triumph of heterogeneity. In *Education, technology and industrial performance in Europe, 1850–1939*, ed. Robert Fox and Anna Guagnini, 65–88. Cambridge: Cambridge University Press.

Kragh, Helge. 1998. Out of the shadow of medicine: Themes in the developments of chemistry in Denmark and Norway. In *The making of the chemist: The social history of chemistry in Europe 1789–1914*, ed. David Knight and Helge Kragh, 235–264. Cambridge: Cambridge University Press.

Kragh, Helge. 2003. Volta's apostle: C. H. Pfaff, champion of the contact theory. *Nuova Voltiana* 5:69–82.

Kragh, Helge. 2009. Conservation and controversy: Ludvig Colding and the imperishability of 'forces'. *RePoss*, no. 4. http://www.ivs.au.dk/reposs. Accessed 21 Nov 2014.

Kragh, Helge. 2012. *Niels Bohr and the quantum atom: The Bohr model of atomic structure 1913–1925*. Oxford: Oxford University Press.

Kragh, Helge et al. 2008. *Science in Denmark: A thousand-year history*. Aarhus: Aarhus University Press.

Nicolson, Malcolm. 1996. Humboldtian plant geography after Humboldt: The link to ecology. *British Journal for the History of Science* 29:289–310.

Nielsen, Henry, and Keld Nielsen, eds. 2001. *Neighbouring Nobel: The history of thirteen Danish Nobel prizes*. Aarhus: Aarhus University Press.

Pedersen, Olaf. 1988. Newton versus Ørsted: The delayed introduction of Newtonian physics into Denmark. In *Newton and the new direction in science*, ed. George V. Coyne et al., 135–153. Vatican State: Specola Vaticana.

Pedersen, Olaf. 1992. *Lovers of learning: A history of the Royal Danish Academy of Sciences and letters*. Copenhagen: Munksgaard.

Pinborg, Jan, ed. 1979. *Universitas Haffniensis*. Copenhagen: University of Copenhagen.

Robertson, Peter 1979. *The Niels Bohr Institute—The early years 1920–1930*. Copenhagen: Akademisk Forlag.

Schmidt-Schönbeck, Charlotte. 1965. *300 Jahre Physik und Astronomie an der Kieler Universität*. Kiel: Ferdinand Hirt.

Snorrason, Egil. 1974. *C. G. Kratzenstein and his studies on electricity during the eighteenth century*. Odense: Odense University Press.

Splinter, Susan. 2007. *Zwischen Nützlichkeit und Nachahmung: Eine Biographie des gelehrten Christian Gottlieb Kratzenstein*. Frankfurt a. M.: Peter Lang.

Wagner, Michael F. 1993. Danish polytechnical education between handicraft and science. In *European historiography of technology*, ed. Dan Ch. Christensen, 146–163. Odense: Odense University Press.

Westfall, Richard. 1994. Charting the scientific community. In *Trends in the historiography of science*, ed. Kostas Gavroglu, 1–14. Dordrecht: Kluwer Academic.

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Chapter 4
Changing Concepts of 'The University' and Oxford's Governance Debates, 1850s–2000s

Andrew M. Boggs

4.1 Introduction

Baron Kenneth Baker of Dorking, while serving as United Kingdom (UK) Secretary of State for Education and Science from 1986 to 1989, once said "When great institutions decline, they do not decline precipitously: there is no precipice. They simply decline very slowly. Higher education is now heading down that slope" (quoted in Stevens 2004, p. 131). Many commentators on universities agree with Baker's sentiments. In particular, histories on university governance and management suggest that these institutions are in a state of fundamental disrepair. With titles like *Decline of Donnish Dominion* (Halsey 1995), *Oxford and the Decline of the Collegiate Tradition* (Tapper and Palfreyman 2000), and *Lowering Higher Education: the rise of corporate universities and the fall of liberal education* (Cote and Allahar 2011), many higher education scholars suggest Baker's statement is correct.

However, what appears as a decline may simply be a transformation. Universities have changed dramatically over time. Each period of transformation has encountered resistance. One of the most widely read works of higher education scholarship, Cardinal John Henry Newman's 1858 *The Idea of a University*, was an attempt to refute the 'university as research centre', an idea taking hold in the mid-1800s. Despite Newman's arguments, the research university became the predominant form of university in the English-speaking world as the higher education systems of the UK (Halsey 1995; Rothblatt 1968), the United States (Rudolf 1990; Thelin 2004) and Canada (McKillop 1994; Boggs 2007) and dramatically expanded through the late-nineteenth and early twentieth centuries. Although older institutions predating this expansion occasionally struggled to adapt to the new vision of universities, they all eventually embraced the ideals of scholar as researcher and university as research centre.

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University governance has undergone significant transformations over the centuries in a parallel process to changing expectations of universities. Shattock (1983) and Boggs (2010) have discussed these transformations as the creation of new institutional governance types within the UK higher education tradition, illustrating that new types tend to coexist with earlier ones. However, each time a new institutional governance type has been introduced, pressure is put on the existing universities to adopt elements of the new one. Oxford University, the oldest institution of higher education in the English-speaking world, has not been immune from this recurring pressure for change. Oxford's governance debates illustrate the nature of wider change in the world of higher education.

Oxford's most recent governance debates were emotionally charged, embroiling the entire institution in a 'civil war of words' over proposed reforms to Oxford's governing bodies. The latest review took place from 2004–2006 and its proposed reforms were introduced by then-Vice Chancellor, John Hood. In order to understand the most recent governance debates at Oxford it is necessary to understand the previous five governance reviews and reforms, taking place between 1852 and 2000. This paper considers Oxfords governance reviews in this time span, as a tool to understand global higher education reform and to contextualize the Hood governance review debates of the early twenty-first century.

4.2 Victorian Reform: 1850s to 1870s

Oxford's current governance structure is part of an ongoing negotiation between various stakeholders both within and outside the university (Halsey 1995; Tapper and Palfreyman 2010; Beesemyer 2006). However, most authors agree that the basic components and principles on which the existing governance structures are based were established following the government reviews of the university in the mid- and late nineteenth century (Rothblatt 1968; Kenny and Kenny 2007).

The Victorian period was marked by radical social, economic, and technological change in Britain. The Industrial Revolution pulled people from the countryside to expanding cities, transforming the traditionally agrarian economy. With urbanization and economic diversification came a new middle class. This middle class asserted itself economically and politically, demanding social change and increased opportunity for the common people. Among these demands was a desire for higher education relevant to new financial, industrial and professional occupations.

Oxford and Cambridge were England's only two universities at the start of the nineteenth century. A changing model of higher education over this century fueled a university reform movement. There were two major factors driving university reform. The first of these was the rise of academic research. Oxford and Cambridge, until the 1850s, were almost exclusively educational institutions devoted to the moral and academic education of undergraduates. There were few graduate students, the central area of academic study was theology, and academics were largely involved in scholarship (that is to say, thinking and reading about their respective areas of academic endeavor) as distinct from research (the generation and publication of new knowledge).

The rise of the Prussian research-based university challenged the Oxbridge conceit of an educationally driven university. While head of education in the Prussian Ministry of the Interior, Wilhelm von Humboldt founded the University of Berlin in 1810. The new university put research, especially scientific research, at the forefront of its mission. Its students were essentially apprentice researchers, learning from participation in the research projects of their professors. A consequence of this research focus was engineering, scientific and economic advancements not seen in Britain. This led the British government and some Oxbridge academics to view the Berlin model as worth emulating at the English universities.

The second source of pressure for university reform came from the changing economic circumstances in England through the early to mid-nineteenth century. Demand for university spaces close to the new centers of economic life, including Manchester, Birmingham and Sheffield, encouraged the British government to put pressure on Oxford and Cambridge to consider extending their resources to these communities. Although both universities did make attempts at 'extension schools' to meet this growing demand, Oxford and Cambridge largely remained the domain of the very wealthy and the aristocracy, offering courses in classical history, theology and philosophy, which were of little use to the burgeoning steel and textile mills and growing locomotive and civic infrastructure demands of nineteenth-century Britain. The country cried out for more engineers, chemists and bureaucrats drawn from the middle classes. Oxford appeared to be far behind the times, still requiring its academic staff to remain celibate, maintaining student enrolment around 450, and devoting few resources to experimental research.

The government felt that Oxford had failed to embrace the concept of the research-based university or accept an expanded role for social mobility. This perceived failure led the British government to approve the creation of new universities throughout the country. Largely driven by local civic groups, many of these new universities have become referred to as 'civic universities'. Between 1829 and 1909, a total of ten new universities were founded in England.

Some higher education thinkers in England struggled to oppose the new, and growing, research ethos. John Henry Newman lobbied the founders of University College, Dublin, to consider the Oxbridge ideal of character education and morality in higher education over the academic specialization prioritized by the German university (Newman 1858). Other anti-reformers within Oxford and Cambridge agitated in favour of the status quo. Those in favor of reform were equally vocal. One of the more radical reformers within Oxford, the Regius Professor of Modern History, Goldwin Smith, lamented what he saw as Oxford's lack of vision (Smith 1868). Many moderate reformers, including Benjamin Jowett, began calling for changes to the university's rules on student admissions, including requiring all students to swear to the Anglican Thirty-Nine Articles of Faith.

The British government's growing support for the Humboldtian university, and Oxford's slow move to change, triggered a government review of the two ancient universities. In 1852, the government announced the appointment of a Royal

Commission to consider the operations and statutes of Oxford and Cambridge. Oxford's Statutes had not been considered in their entirety for 220 years[1]. In addition to concerns over the place of scientific research and graduate education in Oxbridge, these reviews also tackled a number of domestic policy questions, including the connection between university membership and the Church of England and how each institution was governed and managed (Great Britain 1853; Heywood 1853; Searby 1997). This compelled the colleges to open up their student scholarships to competition for all students. The roles of the vice chancellor and chancellor were also clearly defined, empowering the former to oversee the day-to-day operations of the university and redefining the latter as the titular head.

Despite the comprehensive nature of the 1852 university review, a second Royal Commission was struck in 1874. Reformers still in Oxford had continued pressing for a second commission in an effort to see through changes that had not been included in the 1852 recommendations. The 1877 Commission report recommended compelling Oxbridge colleges to contribute funds to a Common University Fund for the purpose of funding professorships employed by the university and for new university officers to oversee university operations. Included in the 1877 review recommendations was the abolishment of celibacy requirements for college fellows and the setting of annual income floor at £ 300/year for fellows to improve academics' living conditions and to make Oxford and Cambridge competitive in recruiting young academics (Spooner: Item 11,334 1928).

4.3 New Role for the State: 1920s

The next period of university reform came in the early 1900s. This period of reform was triggered by two developments. The first of these was the end of the First World War, which led to an influx of students augmented by veteran soldiers returning to civilian life. The second development was the advent of the state-funded higher-education sector. Supporters of further expansion of scientific research and education within Oxford called on Prime Minister Herbert Henry Asquith to appoint a royal commission of review but he was hesitant to involve parliament in a significant review. Asquith opted to leave the university to conduct its own internal review, overseen by Oxford's Chancellor, Lord Curzon. Most of the recommendations arising from Curzon's 1909 report, *Principles and Methods of University Reform*, were rejected by the University Congregation (Prest 1994).

In 1918, the new English universities demanded additional public funds to support their increased scientific and engineering research. Scientific and engineering research had grown dramatically in support of the British military effort over the course of the 1914–1918 war. The government agreed that new university funding was necessary and invited the state-supported universities to make submissions on

[1] While Chancellor of Oxford (1629–1641), Archbishop William Laud led a revision of Oxford's Statutes in their entirety, completed in 1636.

their financial requirements. At this point, "no State aid was given to Oxford and Cambridge universities as such" (Asquith 1922, p. 6) but both universities were invited by the government to make a submissions for ongoing, recurring funding because it was assumed that Oxbridge had also been affected by the war. In response to Oxford's and Cambridge's respective requests, the new British Minister of Education, Herbert Fisher, offered Oxford and Cambridge an annual grant of £ 30,000 provided each university agreed to an inquiry into their operations and finances. Although some opposition was voiced within Oxford, both universities eventually agreed.

This latest Oxford and Cambridge review was to be limited to the respective financial operations of the universities. However, it became apparent that any review would have to include university governance (Asquith 1922, p. 7). Fisher, an Oxford graduate but considered a university reformer, mandated a single review of Oxford and Cambridge together and that the review would not compare the governance structures of the two ancient universities to the newer universities (Prest 1994, p. 31). This direction implied that while Oxford and Cambridge could be compared to each other, the unique aspects of governance enjoyed at both institutions would be protected[2].

Although a single Commission, the Commissioners were divided into two sub groups. One group focused on Oxford and the other focused on Cambridge. No longer Prime Minister, Harold Asquith was named Chair of the combined review of Oxford and Cambridge and also named as lead investigator for the Oxford half of the review. The Commissioners reviewed the finances of both universities and spent a great deal of time examining their management and governance. Like the reviews of the 1850s and 1870s, the Commissioners received recommendations from members of the university through direct consultation and written submissions. Like the commissions that came before it in the nineteenth century, the Asquith Commission tried to limit the number and categories of people participating in the oversight of Oxford. The Commission attacked this issue with two key recommendations. The first was to remove all non-residents of Oxford from Congregation. The purpose of this was to empower only those who had an ongoing, day-to-day interest in the university's teaching and management. According to historian John Prest (1994, p 37):

> The Commission took the view that resident teachers and administrators should be placed in sole charge of the universities and it rejected every proposal for outside nominees to be placed upon the governing bodies.

Individuals with a loose tie to the university, but who only exercised their role once or twice a year, were removed from the most powerful of Oxford's governing bodies.

The second recommendation was to disempower Convocation, the body comprised of all Oxford graduates with the title of Master of Arts. Until Asquith, the division of powers between Convocation and Congregation were somewhat confused.

[2] It should be noted that two of the Commissioners focusing on Oxford were vice chancellors of the civic universities, Manchester and Sheffield, although Oxford graduates.

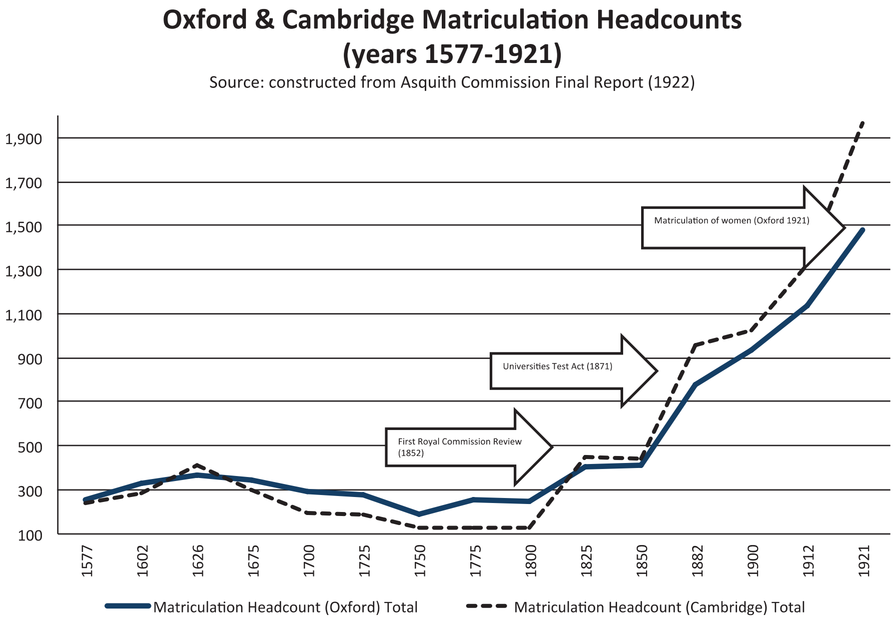
The Asquith recommendations stopped short of disbanding Convocation, but reduced its authority to the elections of the figurehead Chancellor and the Professor of Poetry.

The Commission also identified a significant power imbalance between Oxford's colleges and the central university in terms of wealth, influence and power. The Commission's report argued that the origins of this imbalance went back to the religious policies of Queen Elizabeth I, which advantaged Oxford colleges at the expense of the university's office holders. Once entrenched, the colleges maintained their hold over the university and university policy. According to the Asquith report:

> It must be frankly admitted… that the period which usually regarded as the least satisfactory in the known history of [Oxford and Cambridge], the eighteen century, is closely connected with too great power and too unconditional independence of the College societies. They had divided up nearly all the functions of the University among themselves…. (Asquith 1922, p. 15)

The Commission's recommendations were designed to increase the authority of the university by restricting the ability of the college's to dictate university policy. This included directing the new public funding to the university (rather than the colleges where most of the student teaching took place) and compelling Oxford colleges to consult with the central university when making appointments, with a particular focus on building Oxford's scientific community, which was seen as severely lacking compared to all other English universities, including Cambridge.

In many ways, the Asquith Commission of 1919–1922 (Asquith 1922) completed a process of reform begun in the 1850s, fueled by the increasing prominence of scientific and engineering research within the English university sector and rapid growth in university enrolment. Between 1850 and 1921, student matriculation numbers more than tripled (see Figure). It is important to note that this growth took place after 250 years of relatively stable student enrolment. This is particularly evident in Oxford's case, where the total student population hovered between 300 to 350 students from the 1570s to the 1850s. The Oxford colleges had been a force for conservatism and the status quo—they had not been interested in ensuring rigorous academic standards, pushing the boundaries of academic research or meeting the needs of a growing, literate population. By trying to strengthen the university at the expense of the colleges, the Asquith report attempted to open Oxford to the twentieth century. Universities were now engines for the advancement of scientific knowledge and spreading higher education to a much larger portion of the population. Oxford spent the 1850–1920s catching up with a new, more active university sector.



4.4 Increasing Access and University Expansion: 1960s

Debate over the governance of Oxford began again in the 1960s. This time, the call was for a rapid system expansion and increased access to higher education for all socio-economic groups (Stevens 2004). Like the United States and Canada, in the postwar baby boom era in Britain reform came with a desire for public accountability and centralized decision-making in a period since the 1940s that resulted in a significant increase in the university-age population by 1960. This demographic phenomenon led to a growth in demand for higher education beyond anything that Britain had experienced before.

In 1961, the British government commissioned a review of the entire higher education sector. Chaired by academic and economist, Lionel Robbins, this review considered every aspect of British post-compulsory education, higher and vocational education. Completed in 1963, the Robbins report signaled an expansion of the higher education sector not seen since the nineteenth century, with a planned enrolment expansion of over 100,000 full time university students, representing a 50 % increase over a 5-year period. The actual enrolment expansion was quite different, with an increase of 74 %! Although the vast majority of this excess increase came through non-university higher education institutions, the university sector alone saw a 50 % increase in full-time enrolment (Layard et al. 1969). Britain became a mass higher education country (Soares 1999, p. 171).

One of the major contributing factors to the remarkable increase in non-university enrolment was the creation of the polytechnics. The British polytechnic institutions were intentionally focused on teaching versus research and geared toward meeting the workforce needs of Britain's postwar economy. The polytechnics were a different kind of degree-granting institution in that the academic staff of the institution did not have a say in institutional operations (Pratt 1997). They were overseen and run by a board composed of individuals drawn from outside the polytechnic. This difference from the university community was intentional—the government wanted the private sector, as students' future employers, giving direction to polytechnics (Doern 2008).

At Oxford, the changing environment encouraged the university to reconsider its governance again. Despite some support within the university, the government rejected the suggestion of a Royal Commission, advising Oxford to find its own solution first. The resulting internal review, the Franks Commission, was launched in 1964 (Brock 1966). This review sought to increase the ability of the university to compete for research grants from the growing higher education sector and respond to growing enrolment demands. Two key governance changes attempted to reconcile the colleges with the university while continuing to strengthen central decision-making.

The first key recommendation was the creation of a Conference of Colleges. This body was intended to bring together all of the university's colleges to debate and consider common issues and make binding decisions on policy. While Oxford's Congregation approved of the concept of a formal structure for college discussion, it could not stomach the Conference making binding decisions on legally autonomous colleges within Oxford.

The second key recommendation fundamentally changed the selection of the university's vice-chancellor. Until this point the position of vice-chancellor had rotated amongst the most senior college heads, referred to as 'heads of house'. The Franks Commission recommended the election of vice-chancellor by Congregation to a 4-year term. Although the candidate had to be drawn from the existing university membership, candidates could be drawn from outside the small group of college heads. This marked a significant step in Oxford's progress toward creating an independent and strong central authority.

4.5 Accountability and Efficiency: 1990s–2000s

The late twentieth century ushered in a new era of accountability and maximizing return on public spending. Local authorities and the National Health Service experienced a professionalization of management and the application of performance indicators to assess impact and value for money of policies and programs. The so-called "new managerialism" in the broader public sector (Tapper 2007) pervaded public policy discourse. Higher education became part of this transformation.

This period also introduced a new model of university governance and operations. This time the model for university organization was being driven by North America rather than Germany. European jurisdictions involved in the 'Bologna Process' began recalibrating their tertiary education credentials to emulate an Anglo-American model of academic progression within universities: an entry-level bachelor's degree leading to a 1–2-year master's degree, ending in a research-intensive doctoral degree. While the Bologna Process alone may not have be en the sole driving force for reforms of the European university sector, it did signal an underlying desire by governments to reform their universities and higher education sectors.

Forces running parallel to the Bologna process continue to introduce other new, American-like features to the European higher education sectors. In particular, policies favouring business boards of external representatives for universities, increased private financing of universities (including student fees), and the use of public funds to leverage greater private investment in the higher education sector have appeared in many European jurisdictions, including Britain (Marseilles 2008; Landes 2008). As early as 1988, a new UK Education Act introduced private sector interests to the British university funding councils.

An equally significant shift in the higher education landscape followed new legislation governing the UK higher education sector. The Further and Higher Education Act of 1992 abolished the old University Funding Council, a semi-autonomous vehicle through which the government provided funding grants to universities. In its place, the Act created three new funding councils: the Higher Education Funding Council of England (HEFCE 1998), the Higher Education Funding Council of Wales (HEFCW), and the Scottish Funding Council (SFC). The 1992 Act also fundamentally altered the UK's higher education landscape by dramatically increasing the number of universities in the country and moving responsibility for further education colleges to the central government. Responding to a 1991 White Paper, *Higher Education: A New Framework*, the 1992 Further and Higher Education Act made the vocationally focused, degree-granting polytechnic institutions into universities. Importantly, the Act did not place limitations on the areas of research or ambitions for graduate education of the new universities. Consequently, all universities in the reformed UK higher education sector were pursuing and competing for the same research funds, academic staff, and students.

This new type of university has been referred to as the "higher education corporation" (Shattock 1983). The institutional governance of higher education corporations prioritizes business-boards dominated by external/lay members, along with institutional managers, over academic staff. Many authors have suggested that this new British university type was the natural outcome of rapid growth in university bureaucratization and an increased tendency of the British government treasury to add reporting requirements for use of public grants through the 1980s and 1990s (Salter and Tapper 1994; Soares 1999).

A UK general election in 1997 brought about a sea change in the country's political landscape. Thatcherism departed and the British Labour party returned to government following 18 years in opposition. The new governing party had rebranded itself as 'New Labour', melding the social conscience of the party's traditional left-wing support with support for business, reducing private sector regulation, and applying private sector management techniques to public services. Two months following their election victory the new government announced that it would forge a "new compact" between higher education institutions and "their staff, students, government, employers and society in general" (Stevens 2004, p. 70). The new direction for higher education was to include partnerships with industry, commerce and the public service, intentionally linking higher education with the vocational needs of the UK economy.

This new covenant between the state and UK universities triggered a new, government-mandated, sector-wide review. Led by the Chancellor of the University of Nottingham, Sir Ronald Dearing, the National Committee of Inquiry into Higher Education was struck in 1996, aiming to report in the summer of 1997. The Dearing Committee was tasked with proposing a new financing model for British higher education following the massive expansion of the sector in 1992. The government determined that a new source of income for universities was needed to supplement the public grants institutions received because existing funding was proving inadequate spread over a much larger number of institutions. The Committee published a series of reports on recommended reforms to the UK higher education sector, culminating in a single omnibus report, Higher Learning in the Learning Society, now known as the Dearing Report.

The Dearing report made ninety-three recommendations. Barr and Crawford (1998, pp. 75–76) divided the recommendations into four categories:

1. Quality—including empowering the external quality review agency, the Quality Assurance Agency (QAA), and improving teaching in higher education;
2. Access—including targeted recruitment funds;
3. Funding—including student fees ameliorated by publicly financed and needs-tested grants and loans for students; and
4. Miscellaneous—including recommendation related to institutional governance, articulation between vocational and higher education institutions to improve student movement, and the creation and dissolution of universities.

The Dearing report's recommendations on university governance included the following:

> *Recommendation 54*: We recommend that the Government, together with representative bodies, should, within three years, establish whether the identity of the governing body in each institution is clear and undisputed. Where it is not, the Government should take action to clarify the position, ensuring that the Council is the ultimate decision-making body, and that the Court has a wider representative role, to inform decision-making but not to take decisions. (Dearing 1997)

This recommendation was accompanied by a further series on the composition of university governing bodies and regular government reviews of university governing bodies. The report recommended (Recommendation 55) that all university governing bodies should include students and staff, and contain "a majority of lay members"; Oxford did not comply with this. The report also highlighted a need for ongoing assessment of governance effectiveness. Recommendation 57 stipulated that universities should review their governing structures and their functions once every 5 years.

The Dearing Report also identified the need to ensure compliance with its recommendations. Recommendations 58 and 59 of the report placed the university funding councils in charge of ensuring universities' governing bodies were upholding the recommendations on university governance:

> We recommend that, over the medium term, to assist governing bodies in carrying out their systematic reviews Funding Bodies and representative bodies develop appropriate performance indicators and benchmarks for families of institutions with similar characteristics and aspirations.
> We recommend to the Funding Bodies that they require institutions, as a condition of public funding, to publish annual reports which describe the outcomes of the governing body's review and report on other aspects of compliance with the code of practice on governance. (Dearing 1997)

The Dearing report supported the view that Britain's universities were in the public sphere, assuming public accountability for their operations and, consequently, their governance structures.

Oxford decided to undertake its own internal review on the heels of the Dearing Report. At the time of the Dearing Review, Sir Peter North was Vice Chancellor of the university. North had served as Principle of Jesus College prior to this appointment as Vice Chancellor. A lawyer by training, he had spent a considerable part of his professional career outside of the university before returning to academe. In Sir Peter's words:

> I became a member of what was then called Hebdomadal Council, the university's council, in 1985 having just come back to Oxford having been out of university life for almost a decade. I became Principal of Jesus in '84, was elected to council in '85, and rapidly found myself chairing what would now be called the finance committee, curator of the University Chest as it was known then. So I found myself pretty centrally involved in the financial dealings of the university. (North interview, 8 September 2010)

Sir Peter was convinced Oxford needed to reconsider its operations based on his experience at Curator of the University Chest. However, he felt trying to compel the university into an operational review too early would be ill advised:

> I certainly wasn't going to do anything in my first term in office, even though I was very familiar with how the university worked. I just thought that was not politic… Coming to the beginning of my second term, I said, "I really think we need to have a hard look at what we do and how we do it." The last big look was the Franks Report in the mid-1960s. This was now the mid-1990s. We had run the regime which had emerged from that for thirty years or so. I was actually as much concerned about what we did as much as how we did it. I don't just mean what the governance was. I mean how the university actually did things, and the things that it did and why it did them. So, I said, "I think we ought to have a good look at this." And in its wisdom council decided it would set up a committee to think about what it would do. (North 2010)

According to North the university was not under any pressure from particular external bodies, including government, to consider reform. However, he does acknowledge there were environmental issues that contributed to his thinking on university governance. Sir Peter suggested these issues fell into two broad categories. First was recognizing the growing global marketplace for higher education, and that Oxford University operated in a transnational market. The second, and related, was seeing British higher education as an international export and an economic driver for the UK.

Oxford was awakening to the potential student market in China. North described a joint trip he and the Chancellor of the university, Lord Roy Jenkins, took to China:

> We used to comment to each other that it was the first time that we believe it had ever happened that the titular head and the administrative head of the university actually planned a trip abroad together. It wasn't the first time that they had both turned up in the same place. There had been visits to New York, for example, to meet alumni and that sort of thing. But this was an actual joint effort which was aimed at developing links with universities in China…. A decade earlier people would have asked, "What the hell are you playing at in going to China?" So, that sort of international pressure was developing. But it was internal. It wasn't government saying you should do this or that. (North 2010)

Seeing Oxford as an international institution was not new, but the university administration strategically targeting elements of a global higher education marketplace in the 1990s was a new development. According to Sir Peter, "I don't think people thought like that earlier" (North 2010). A trip abroad by Oxford's Chancellor or Vice Chancellor had previously been devoted to alumni relations and fundraising. In the 1990s, these trips become more focused and included student and staff recruitment.

Higher education's role in economic development was a second emerging concept Oxford and other higher education institutions were facing. As of the late 1990s, overseas government economic missions now included a higher education component:

> We didn't have a recognition by government of invisible exports being provided by universities. [Prime Minister Tony] Blair went on a visit to India in about 2005, and [Oxford Vice Chancellor] John Hood was one of the people who went with him. [Prime Minister David] Cameron has just been on a visit to India. I know that there were vice chancellors that went on that visit; though I don't know whether ours or Cambridge's went. However, I don't think anybody would have contemplated asking me or my opposite number in Cambridge to have gone on some financial-political visit abroad. It just wasn't what you did. "What's the point?" would have been the question. (North 2010)

Universities, particularly those with global name recognition, had become a component of economic outreach between governments. Oxford's ability to capitalize on its new privileged position within the government's international economic strategy required different administrative and governance skill sets.

These two environmental pressures, the emerging global marketplace of higher education and recognizing higher education's economic importance, impacted Oxford thinking on how the university needed to be organized. This led to a minority feeling that the university needed to reconsider its operating structures.

The Hebdomadal Council moved to create a commission to review Oxford's operations (University Oxford 1966). The scope of the review was quite broad, leaving very few aspects of Oxford unexamined. The membership of the commission was designed to represent Oxford's academic constituencies, and included two external academics, for a total of eight members:

> …a science professor, an English professor, somebody with prior experience from a graduate college involved with graduate admissions and graduate work, a tutorial fellow, me. That was six from within Oxford. And then there were two outsiders: somebody who became the Rector of Imperial College and someone who was a Cambridge head of house. (North 2010)

Notably, the commission did not include any administrative staff or students. North had not intended that he serve on the commission when he first made suggestion that Hebdomadal Council consider a university review. The Council made the decision that the vice chancellor should not only be a member of the review and that he should chair its work. The commission began meeting in the summer of 1994 and was intended to report back to the Council and Congregation within 2–3 years. The commission had a broad scope, and included both the university's work and operations. The commission considered what the university did, including undergraduate education, as well as how the university approached its work, including institutional governance:

> We took the decision very early on that we would employ consultants to assist in the work. The central issue was not just "what should be the structure of faculties, departments, central areas of the university?" It was equally important to ask "what should we be doing?" And those parts of the report on this latter aspect haven't, in my view, had such a high profile as those parts dealing with structure and governance. We considered that it was very important to look, and have the mechanisms to look (which we now have), at how we teach and, particularly in the case of undergraduates, how we examine. We need to consider how we teach and how we examine. (North 2010)

The commission's decision to retain consultants to support the review provided controversial, with members of the university community complaining that outsiders without university experience would have little to add to the review. Although the commission proceeded with engaging consultants, it chose to invite submissions from the Oxford community to be sent directly to the commission:

> On the Commission of Inquiry we employed consultants, which the less radical people in the university thought was an absolutely monstrous thing to do because, in their view, all you do is pay a lot of money to very young people who are not experienced at all who will merely regurgitate back to you that which they have heard in consultation. What was interesting was that the consultants came in and produced what I thought was actually a very good diagnosis of issues that needed to be addressed in the university. And they also produced prescriptions for dealing with them. At which point the university at large said "preposterous". Not at the diagnosis. Very few people focused their minds on the diagnosis. They focused their minds on these "ridiculous suggestions" as to what should be done. We then went through a process of taking evidence from everybody under the sun, both written and oral and we compared the proposals with the way things were then done. It was a long process. We had regular weekends away on the work of the Commission. (North 2010)

Once the consultants reported, there was widespread agreement that the consultants correctly identified and summarized the issues with which the university was struggling. However, there was not agreement that the consultants' proposed solutions were acceptable.

In the summer of 1996, the British government asked Sir Peter North to lead a commission on the 'troubles' in Northern Ireland. The Oxford commission agreed to release its chair to devote his time to the Northern Ireland review. The Oxford commission continued collecting evidence and to work with the consultants, but Sir Peter's absence, which lasted until February 1997, delayed the Oxford commission's report.

The commission supported the management and organizational principle of subsidiarity. Subsidiarity promotes locating decision-making at a point as close as possible to where the decision's impact will be felt. It is sometimes referred to as decision-making at the lowest possible management level or localized management. The commission's goal was to achieve subsidiarity for Oxford's academic management:

> [The commission] said that there should be a divisional structure… the philosophy… our underlying philosophy, as far as structure was concerned, was you should generally push decision-making down to the lowest possible responsible level. You should take the broad strategic and difficult decisions, and have the mechanism to make difficult choices, in the center. And having made those choices, responsibility should be delegated, so you get a thousand flowers blooming, or attempting to bloom, coming up. (North 2010)

The proposed divisional structure replaced the General Board, a body representing all of the university's academic departments. However, because it had to consider the interests of all departments and the size of its membership, the General Board had become dysfunctional:

> There was the equivalent of all the divisions in the form of a body called General Board. And it had to do, for the whole the university, what the divisions do now, in a way, for their sectors. So, [the General Board] didn't do it terribly well because it was too big a job. The only way it could really do it was by taking a rather centralized view. What the divisions did…was to provide the capacity to push responsibility down. The divisions could be given assets, whether physical or monetary, in large chunks, with Council saying "You can come and argue to us, Council, about how large your chunk should be. But, once you've got it, you, who are skilled in these matters, must take the decisions about which of these things are going to blossom". The university didn't have a mechanism for doing that [previously]. (North 2010)

The North review proposed to reorganize the university, moving management of academic departments down from the center of the university.

A second principle guiding the North Review was a desire to better integrate the colleges into university decision-making. The governance structures designed by the Franks Commission had evolved in such a way that the colleges or the university could make decisions without consideration for those decisions' impact on the other body, leading to policies that were in direct contradiction:

> … the system did not work terribly well. I don't think it's a structural problem, rather a behavioral one…. colleges were not as conscious as they ought to be of the pressures on the university at large over a whole variety of things. There was a danger that [colleges would] sit in their little castles and fire arrows at anybody that came near them. If you could get them to provide individuals to share some of the wider responsibilities by having more college members on the major university bodies, they would be able to do two things. First, they'd be able to say to the university, "Actually, trying to do that will cause a huge problem," or, "Doing it that way will cause a huge problem for colleges, but you can do it this way which won't." Secondly, they would bring back into the colleges a greater understanding of some of the pressures the university has got, increasingly from outside….

> I wasn't convinced at the first part of this decade that those elements worked particularly well. Though I think, from what I hear, they work better. We were trying to make sure there was, if you like, an integration of understanding. (North 2010)

However, the commission's success at better integrating the college's into university decision-making and increasing subsidiarity within university management is contested. One head of house described the two camps that emerged leading up to the 2004 launch of John Hood's review of Oxford's structures:

> I think there were probably two groups of people, really. One, to which I belonged if it was a group, which took the view that the unfinished business of North was the colleges, and how you got college input and buy-in to decisions made at the center. And I thought that did need attention.
> There was another group, as it turned out, as appeared in the governance debates in Congregation, who thought that… centralization had gone much too far…. And the confusion over the new online accounting system seemed to them to prove that they were right and there needed to be much more consultation than was happening. I think that was the situation. (Slack interview, 10 March 2010)

The North commission proposed three Academic Divisions, each with its own budgetary and planning powers cutting across and in parallel to the colleges of the university:

> As a consequence, you needed a divisional structure to provide the means of taking these decisions. The university at the top has got to decide how much money it's got and where it should put it, but it shouldn't be micromanaging medicine or whatever. The medics should be told, or the arts people should be told: "You've got these assets available. Now you make sure you choose the best things and make your own difficult choices." That way you encourage growth; you do your best to avoid inhibiting cross-border activities. So we concluded that there should be just three divisions. (Slack 2010)

Although the commission's recommendations were not entirely dissimilar from the recommendations proposed by the commission's consultants, there was more agreement within the university for how these proposals were characterized by the commission:

> At the end of the day, we came out with what were, for then, some quite radical proposed changes. But they were not very obviously the detailed changes, which the consultants had proposed. So we got brownie points for wisdom for having listened to the robust comments on all the "ridiculous" proposals the consultants had put forward, even though actually quite a lot of what we proposed was not a million miles away.
> …of course it was left to my successor to carry through the implementation of the recommendations… my judgment was that the university didn't argue about the diagnosis at all. It didn't argue all that much about the prescription. It did argue a fair bit about the colour of the pills. (Slack 2010)

One area in which Oxford's Hebdomadal Council was not in entire agreement with the commission was limiting the new structure to three divisions. Councilors expressed concern that some departments could not be grouped together for political reasons. In Sir Peter's words:

> Council decided the politics of that were too difficult. So it was decided to have five divisions, i.e. social science, humanities, medicine, life sciences and physical sciences. This was understandable for political reasons in getting the new structure agreed by the university at

> large. However, I thought it was particularly unfortunate in relation to the separation of the life sciences from medicine, because it is actually very hard to distinguish activity there. And what's interesting is that actually that separation has now gone. I mean, the light was seen. I also think that there are inhibiting factors in separating humanities and social science. But that's politics. (North 2010)

As a consequence, the Council revised the commission's recommendations before presenting them to Congregation for consideration. Five divisions were included with the commission's recommendations. Congregation approved the North Review's proposals, to be implemented over the course of the next vice chancellor's term of office.

The North Commission Report makes reference to the Dearing Report's commentary on university governance, including a preponderance of external representation on governing councils. The North report recommended, for the first time, that Oxford's Council should have members drawn from outside, or external to, the university. The report recommended adding two lay members to the University Council.

The North Review's recommendations, including the two externals on Council, were implemented in 2000. The University Council wanted to ensure that the new structures would be assessed and set a 5-year time horizon for an operational review. However, this timeframe meant that the operational review would likely take place during the tenure of the Vice Chancellor to follow then-Vice Chancellor Colin Lucas. Professor Paul Slack was appointed Pro Vice Chancellor (Academic Services and University Collections) by Lucas in 2000 and was involved with the North Review implementation:

> It had been agreed in 2000, when the post-North governance system was set up, that it would be reviewed after five years. And before John Hood came in, Council had agreed that John Hood, as the new Vice Chancellor ought to be the person to chair the review. That may or may not have been the right decision. I'm not sure about that. He came in with ideas of his own. And although he had people on the working group doing the review, who knew how the system had worked, his was very much a fresh mind, I think, coming to it from outside, but looking at issues which had already arisen in the previous two or three years. (Slack 2010)

The North Review recommendations were largely supported within the university with the expectation that the new divisions would result in more opportunities for input to university decision-making. According to Paul Slack:

> My impression at the time was that the North proposals were generally welcomed. No doubt for different reasons by different people. The devolution of financial responsibility, subsidiarity, which was the phrase at the time—that is to say you devolve decision making to the lowest point where it makes sense to take that decision—that was welcome because people thought it would give them a say in their financial futures, especially financial decision making. (Slack 2010)

However, there may have been concern that the divisions, rather than pushing decision-making down to the academic rank and file, had perversely generated a powerful new administrative force within the university. Paul Slack suggests that this phenomenon contributed to a malaise over Oxford governance:

> It may not have been appreciated at the time when North was accepted how powerful the heads of division would be as managers of a whole sector, a fifth of the university, medical sciences and so on. And those heads of division, who were all colleagues of mine, members of the senior management team, all had to carry their divisions with them and each had a divisional board. But they were in some respects chief executives of their parts of the university. And I think if you were in a small department in a large division it might well have felt as if you had less control over what you were doing, given the existence of these divisions negotiating directly with the center, than you had as a member of a small faculty board like theology for instance. I think there may have been a feeling of loss of control when the intention had been to move control downwards. It strikes me that this is how many governance systems work in practice. (Slack 2010)

The appointment of Vice-Chancellor John Hood in 2004 corresponded with the automatic review built into the North Report. This automatic review was in keeping with recommendation 57 of the Dearing Report that suggested universities conduct a review of governance operations once every 5 years (Dearing 1997). Hood's appointment was historic in that he was recruited from outside Oxford and that his experience was largely in private sector corporate governance. Debates arising from this 2004–2006 review process focused on the question of external representation in the university's governance structure, including the re-composition of an Executive Committee with a majority of members drawn from outside the university, although possibly Oxford alumni (University of Oxford 2005; University of Oxford 2006).

The proposed Hood reforms were significant for two reasons. The first is that they represented a reversal in the policy established in the nineteenth century that firmly removed individuals without an ongoing, day-to-day interest in the operations of the university from the central governing bodies (Smith 1868; University of Oxford 2005). The second reason is that the proposed changes would have brought Oxford much closer to the bicameral university governance structure found at most other universities in North America and the United Kingdom, as codified by the UK Council of University Chairs' "Governance Code of Practice" (Burns 2009a) and "General Principles of Governance" (Burns 2009b). The Hood Report recommendations included a board dominated by appointees appointed by Congregation but drawn from outside the university balanced by the academically dominated Congregation. After a year full of proposals, counter proposals, and often-heated debate, the university Congregation rejected the Hood recommendations in 2006.

Conclusion

The concept of a single chief executive of the university overseen by a business board comprised of community and lay representatives was and continues to be an anathema at Oxford (Bamforth 2006; Slack 2007). Those responsible for Oxford's governance are still drawn almost exclusively from the academic membership of the university itself (Beesemyer 2006; University of Oxford 2005). This is often referred to as "collegial self-governance" (Halsey 1995; Tapper and Palfreyman 2010). However, the precise definition of who is considered to be a member of the university for the purposes of university governance has evolved over time. Before the government reviews of the mid-1800s, the academic-dominated Congregation included individuals who were fellows of Oxford colleges in name only, living and working outside of the university and, indeed, Oxford itself. In the interest of empowering those individuals who best understood university operations, one of the main governance reforms of the nineteenth century put limitations on those who could claim university membership for governance purposes (Smith 1868). And, despite the slow pace, Oxford did evolve in response to its changing environment. Furthermore, although there have been government reviews of Oxford's governance, reform is more typically driven by members of the Oxford community itself, including alumni and academic staff.

The latter half of the twentieth century has witnessed a slow reversal of the reforms of the nineteenth century. The competitive global higher education market, concern over accountability for public funding, and new thinking around corporate governance are influencing perspectives on good practice in university governance. For Oxford, this has translated into 150 years of intense scrutiny of its governance structures and operations. At times, these governance reviews and reforms have been tumultuous, dividing the academic staff of the university. Changes to the funding of universities through the 1990s and the North reforms have triggered a renegotiation of the relationship between Oxford's colleges and the university, while the university as a whole tries to understand its changing role in national and international higher education. The 2004–2006 Hood reform debates, often very divisive, cannot be taken in isolation. As with the previous five periods of governance review and reform, the Hood period is closely tied to changing circumstances in the world of higher education policy and is part of a narrative that began over 150 years before.

References

Asquith, H. H. 1922. *Great Britain Royal Commission on Oxford and Cambridge Universities*. Report [and Appendices]. London: H.M. Stationery Office.

Bamforth, N. 2006. There's no need to be charitable over external governor appointments. *The Times Higher Education*. http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=407677. Accessed 8 June 2009.

Barr, N., and I. Crawford. 1998. The dearing report and the government's response: A critique. *Political Quarterly* 69:72–84.

Beesemyer, L. 2006. Who runs Oxford? An examination of the university's governance structures. M. Sc. Higher Education. University of Oxford.

Boggs, A. M. 2007. Ontario's royal commission on the University of Toronto, 1905–1906: Political and historical factors that influenced the final report of the Flavelle commission. Master of Arts. University of Toronto.

Boggs, A. M. 2010. Evolution of university governance types in England and Scotland. *The New Collection* 5:1–8.

Brock, M. G. 1966. *The Franks report: An Oxford view*. London: British Universities Annual.

Burns, A. 2009a. Governance code of practice. In *Committee of University Chairs guide for members of higher education governing bodies in the UK,* 13–16. Bristol: HEFCE.

Burns, A. 2009b. General principals of governance. In *Committee of University Chairs Guide for member of higher education governing bodies in the UK,* 17–35. Bristol: HEFCE.
Cote, J., and A. L. Allahar. 2011. *Lowering higher education: The rise of corporate universities and the fall of liberal education*. Toronto: University of Toronto Press.
Curzon, G. N. 1909. *Principles and methods of University Reform: Being a letter addressed to the University of Oxford*. Oxford: Oxford University Congregation.
Dearing, R. 1997. *The national committee of inquiry into higher education*. London: H.R.M. Printers. https://bei.leeds.ac.uk/partners/ncihe/. Accessed 8 Aug 2012.
Doern, B. 2008. *Polytechnics in higher education systems: A comparative review and policy implications for Ontario*. Toronto: Higher Education Quality Council of Ontario.
Great Britain Royal Commission on Oxford and Cambridge Universities. 1853. Report and evidence upon recommendations of her majesty's commissioners for inquiring into the state of the University of Oxford presented to the board of head of houses and proctors, 1 December 1853. Oxford: Oxford University Press.
Halsey, A. H. 1995. *Decline of donnish dominion: the British academic professions in the twentieth century*. Oxford: Oxford University Press.
Heywood, J. 1853. *The recommendations of the Oxford University Commissioners, with selections from their report*. London: Longman, Brown, Green, and Longmans.
Higher Education Funding Council for England (HEFCE). 1998. Letter to the secretary of state for education and employment, November. http://www.HEFCE.ac.uk/news/HEFCE/1998/oxcamfee.htm. Accessed 2 Sept 2011.
Kenny, A., and R. Kenny. 2007. *Can Oxford be improved?: A view from the dreaming spires and from the satanic mills*. Exeter: Imprint Academic.
Landes, D. 2008. No more free education for non-Europeans. *The Local*. http://www.thelocal.se/12594/20080623/. Accessed 26 Aug 2009.
Layard, R., J. King, and C. Moser. 1969. *The impact of Robbins*. Harmondsworth: Penguin Education Special.
Marseilles, M. 2008. Cheque-book higher education. *University world news*. http://www.universityworldnews.com/article.php?story=20080814153437830. Accessed 8 June 2009.
McKillop, A. B. 1994. *Matters of the mind: The University in Ontario 1791–1951*. Toronto: University of Toronto Press.
Newman, J. H. 1858. *The idea of a University*. 1964 ed. New York: Holt, Rinehart and Winston.
North, P. 2010. Interview, 8 September. Author's personal papers, Oxford University Department of Education.
Pratt, J. 1997. *The polytechnic experiment, 1965–1992*. Buckingham: The society for research into higher education & Open University Press.
Prest, J. 1994. The Asquith Commission 1919–1922. In *The history of the University of Oxford: The twentieth century,* ed. B. Harrison, vol. 8, 27–44. Oxford: Clarendon Press.
Rothblatt, S. 1968. *The revolution of the dons: Cambridge and society in Victorian England*. London: Faber and Faber.
Rudolf, F. 1990. *The American College and University: A history*. 2nd ed. Athens: University of Georgia Press.
Salter, B., and T. Tapper. 1994. *The state and higher education*. Ilford: Woburn Press.
Searby, P. 1997. *A history of the University of Cambridge, volume III, 1750–1850*. Cambridge: Cambridge University Press.
Shattock, M., ed. 1983. *The structure & governance of higher education*. Guildford: Society for Research into Higher Education.
Slack, P. 2007. Governance and change: Oxford in the twenty-first century. Address given to the Oxford and Cambridge club, March 29. Author's personal papers, Oxford University Department of Education.
Slack, P. 2010. Interview, 10 March. Author's personal papers, Oxford University Department of Education.
Smith, G. 1868. *The reorganization of the University of Oxford*. Oxford: James Parker and Co.

Soares, J. 1999. *The decline of privilege: the modernization of Oxford University.* Stanford: Stanford University Press.

Spooner, W.A. 1928. Personal papers, Item 11,334. New College Archives, Oxford University, Oxford.

Stevens, R. 2004. *University to Uni: The politics of higher education in England since 1944*. London: Politico's Publishing.

Tapper, T. 2007. *The governance of British higher education: the struggle for policy control*. Dordrecht: Springer.

Tapper, T., and D. Palfreyman. 2000. *Oxford and the decline of the collegiate tradition*. London: Woburn Press.

Tapper, T., and D. Palfreyman. 2010. Collegial tradition in the age of mass higher education. London: Springer.

Thelin, J. R. 2004. *A history of American higher education*. Baltimore: Johns Hopkins University Press.

University of Oxford. 1966. *Commission of inquiry: Report of evidence*. Oxford: University of Oxford Hebdomadal Council.

University of Oxford. 2005. Oxford's governance structure: A green paper. Oxford: Oxford University Gazette, vol. 136, Michaelmas Term, Supplement.

University of Oxford. 2006. White paper on university governance. Oxford: Oxford University Gazette, vol. 136, Trinity term, Supplement.

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Chapter 5
Challenging the Backlash: Women Science Students in Italian Universities (1870s–2000s)

Paola Govoni

5.1 In the Long Term

"One of the major developments of the nineteenth century that is now often taken for granted was the rise of higher education for women" (Rossiter 1982, p. 1). This is how the first important book on the history of women in science in America—now a classic in the history of science—starts. From its very beginnings, women's entry into universities set off a series of consequences that changed the cultural, social and economic history of the western world, and not just for women (among many, see Newcomer 1959; Bryant 1979; Paletschek and Pietrow-Ennker 2004; Rowold 2010). At the time Margaret Rossiter's reconstruction of the relationships between women, men and science in higher education was making an impact, Evelyn Fox Keller was researching into gender dynamics in the making of scientific knowledge. When she was asked what she was learning about women with her research she replied: "It's not women I'm learning about, so much as men. Even more, it is science" (Keller 1985, p. 3). Since then, and confirming her words, the research on gender and science has gained recognition as an indispensable theoretical and historiographical instrument for our understanding of science and its history (Golinski 2005; Heilbron 2003). It has helped us gain greater awareness of scientists, men and women, for the role played by gender in the laboratory and in the field, as well as in their lives (Schiebinger 2008). Despite these significant cultural and social advances, it is well known that the difficulties faced by women scientists everywhere in reaching the highest professional positions in universities remains a problem (Abir-Am 2010; Moss-Racusin et al. 2012; EU 2009, 2012; Rossiter 1995 and 2012).

The subjects so far briefly referred to remind us that the relationships between men and women in a university not only have social and institutional repercussions, but also significantly influence the making of science. The case presented here,

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restricted to the relationships between women and science in Italian universities using quantitative and long-term data, should be read against the background of those wider issues.

A phenomenon well known in the international community of historians of science, many women in Italy were involved in natural philosophy already in the eighteenth century. To follow the dialogue on natural philosophy between men and women in the Republic of Letters—in their correspondence, in the *salons*, in the academies and sometimes in the universities—has led in some cases to new readings of how the institutions of higher learning functioned, new interpretations of the relations between natural philosophy, religion, and society, new readings of the Enlightenment (Findlen 1995; Mazzotti 2007; Cavazza 2009; Messbarger 2010).

Learned women at work in eighteenth-century natural philosophy in Italy did not have degrees; the very few who did have one succeeded thanks to special sets of circumstances and whose 'exceptional' character was always emphasised, as in the well-known case of Laura Bassi (Findlen 1993; Cavazza Forthcoming). When in the nineteenth century the voices of 'normal' women began to be heard, if rather faintly, demanding access to higher education, unlike other countries in Italy laws forbidding them from entering the university were never introduced. Yet it was only after the political unification of the country (1861) that female education began to be thought about seriously, and this coincided with the wave of feeling created by the *Risorgimento* and the politics of unification. The push was supported by liberal politicians and intellectuals, among whom there were many women, often aware of trends beyond Italy's borders through their own experience (on the Italian history of the period see Soldani and Turi 1993-1996; Zamagni 1997; Davis 2000). The general cultural background was that of a profoundly Catholic country, looking upon higher education for women with the professions in mind with great suspicion. And Italy's social and economic situation was so backward that heated debates on education took place in a context in which illiteracy at the national level after unification stood at 75%, with women's illiteracy, on average, between 10 and 15% higher than that (Cipolla 1969; De Fort 1995; De Mauro 2011). Despite these difficult circumstances, the first women university students are in evidence in Italy, perhaps only as 'auditors', already at the beginning of the 1870s. They were a very small elite belonging to the middle class, and often in the north of the country. According to the official figures, between 1877, the year of the first degree (in medicine), and 1900 there were 224 women graduates (Ravà 1902). Everywhere in the West these were the years of the 'first wave' of feminism, as well as innovation in the universities (Porciani 1994; Offen 2000; Rüegg 2004). But they were also the decades of 'science for all', an important complex phenomenon in Italy, as elsewhere in Europe at that period (Bensaude-Vincent and Rasmussen 1997; Papanelopoulou et al. 2009; Fyfe and Lightman 2007; Schirrmacher 2013), and which, as we shall see, influenced the choices of the first Italian women graduates.

Since that time, the number of women in Italian universities has increased to a remarkable degree, which not even the most optimistic suffragettes and suffragists of the 'age of progress' would have believed possible; they have become more numerous than male students, even at the level of doctorates, and have achieved an excellent record in the field of science (Miur 2011; EC 2009, 2012). In a society

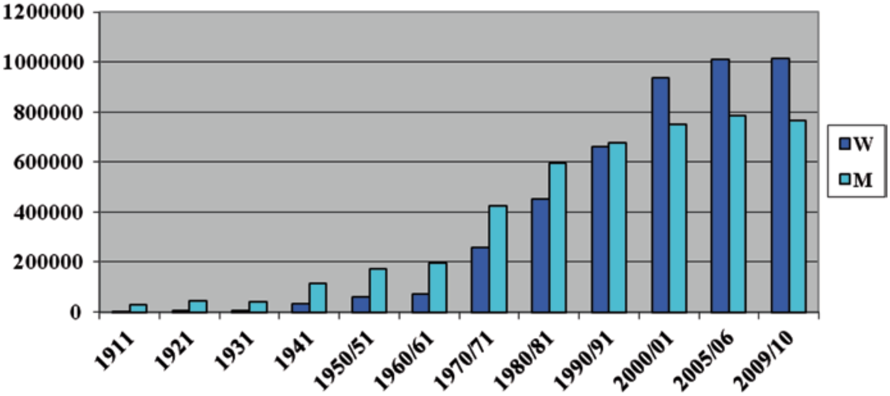

Fig. 5.1 Female and male students, period 1911–2010, absolute values. (From data of the Istituto Nazionale di Statistica [National Institute of Statistics], in Govoni 2009a, p. 234)

like Italy's, characterised by very slight social mobility, from unification to the present day, women are the only social actors to have shown such great determination to emerge in the field of higher education. The graph in Fig. 5.1, to which I shall return, tells the successful end of the story I am reconstructing here. A happy ending in the area of educational formation but not so happy in the area of research, as we shall see.

The changing relationship between women and science in higher education over time is of great interest for historians of universities and science. It opens up enquiry into questions such as why did scientists in Italy at the end of the nineteenth century, unlike in other countries, not oppose the entry of women into universities? Which factors, national and supranational, decided women to opt for science faculties, or put them off? Does the history of the relations between women and men in science faculties emerge as a useful instrument to test the strategies, whether pursued or contingent, of scientists and their communities; in other words, is it useful for our understanding of what scientists do to construct their professional communities?

In the attempt to give a first, partial answer to these questions, I shall be providing data here on the presence of women in science faculties in Italy from 1877 to the present day, examining in greater detail the data on the Liberal age, between unification and the beginning of the 1920s, and on Fascism (1922–1942). After First World War, the women graduates in science who decided to continue their research in universities were faced with a first backlash, the name given to what happened as women were increasingly shut out, after the advances made at the beginning of the twentieth century in the United States and United Kingdom (Rossiter 1982, p. 122; 190–193, 269–270; Dyhouse 1995, p. 138). The argument I am putting forward here is that the brake on the achievement of women's professional success in Italian science faculties in the 1920s and 1930s, after the advances of the first generation of women graduates in science, was not necessarily or in the first place the result of Fascist policies (on the relationships between women, gender, and Fascism, see De Grazia 1992; Durham 1998.), it was rather the effect of the behaviour of one particular group, of academic scientists, who during the First World War had brought to completion the formation of what historians of science call a national community of experts. Only with the Great War of 1914–1918 did Italian scientists become an actual professional group, aware of itself and its powers, its needs and ambitions; a group now able to recognize women as a potential competitor (Govoni 2013, for overviews of the history of women in nineteenth-century Italy, see De Giorgio 1992; Willson 2009). During the First World War, women had begun to increase in numbers in the university, in particular in the science faculties. From that point onwards, in Italy as elsewhere, women suffered from strong pressure aimed at containing their ambitions in the universities. On examining the long-term data, however, a second more evident 'backlash' would seem to be the one happening now, more than twenty years after the time that the number of women graduates overtook that of men in Italian universities.

5.2 'Women in a World Without Women': The International Context in the 'Age of Science'

In his well-known book David F. Noble examined how from the first millennium of the Christian era women were banned from using and producing knowledge, especially scientific knowledge, in institutions of monastic origins such as academia and universities. Yet, in the last chapter of his book, *Women in a world without women*, Noble relates how in the U.S. around the 1830s there began the victorious adventure of western women in universities (Noble 1993: Chap. 10). Noble's controversial work called attention to the uses of a comparative, long-term historical approach, well suited to the Italian case. This kind of broad view enables us to realise that the history of women in the universities and in science in Italy has not been one of gradual progress; in addition, it allows us to notice interesting and by no means obvious time lags between the situations in countries like the United Kingdom, and others in the 'periphery' of science, like nineteenth-century Italy (on the centre-periphery concept, see Gavroglu et al. 2008).

The women who achieved the most encouraging results in the nineteenth century were American. In 1835 Oberlin College (1835) was founded, the oldest American college for both men and women, followed in 1837 by the Mount Holyoke Female Seminary. In both colleges the sciences and mathematics played an important role in the curricula. In a climate of widespread hostility towards women who wanted a higher education of quality, it was only in the 1860s and 1870s that women began to be admitted to male colleges. At this time coeducational institutions such as Cornell University (1865), and women's colleges still outstanding for their educational standards were founded: Vassar at Yale (1865), Wellesley at Boston (1875), and Radcliffe at Harvard (1879). These are the best-known examples of a relatively ideal situation that European women involved in the battle for access to universities looked to as a model (Lange 1890). In the United Kingdom, the first colleges for women were Queen's College and Bedford College, in the 1840s. London

University in 1878 was the first to give degrees, followed by the universities of Edinburgh and Aberdeen, with the exception of the medical faculties. However, thanks to a group of very special women, in 1876 the London School of Medicine for Women was set up. The London School of Economics was important for the history of women's higher education, beginning its courses in 1895 thanks to ideas and funds from members of the Fabian Society, and open to women from the start because of this. On the other hand, the relationships between women and the universities of Oxford and Cambridge were difficult for a very long time: Oxford gave degrees to women in 1920 and Cambridge in 1947. This backwardness, as has been noted, "is perhaps more directly relevant to the history of the University than to that of the movement for female emancipation" (McWilliams Tullberg 1998, p. 1). Anyway, even there, thanks to the commitment of a few enlightened men and women since 1869, it was possible for women to enrol in colleges like Hitchin College (later Girton), Newnham, Margaret Hall, and Somerville. In continental Europe, French women were admitted to universities in 1863, Lyon being the first to open its doors to them, while in Paris the first woman to enrol was accepted in 1867. In the German-speaking world Zurich University was the first, in 1867, to permit the enrolment of women. In the academic year of 1898–99 in Switzerland, of the 4.438 students enrolled, 937 were women, the majority Russians (Tikhonov 2002). From 1859 hundreds of women had enrolled in Russian universities, but between 1863 and 1864, through strong social pressures, the lecture halls of the universities were closed to them, and would remain closed until 1878. This was the reason why many female Russian students were driven to leave the country for Western Europe: the first woman graduate in mathematics and physics at the Sorbonne was the Russian Elena Lej; the first woman graduate in Italy in 1877, in medicine, was Ernestina Paper from Odessa; the first woman to obtain a chair in a modern university—after the eighteenth century case of Laura Bassi at Bologna in 1732—was the Russian mathematician Sofja Kovalevskaya, at the University of Stockholm in 1889. In Germany only between 1900 and 1909 were women admitted on equal terms with men in the various states. In Spain women were admitted on equal terms with men in 1910 (Lange 1890; Bryant 1979; Brock and Curthoys 2000: Chap. 10; Christen-Lécuyer 2000; Gouzévitch and Gouzévitch 2000; Mazón 2003; Ringer 2004; Pomata 2004).

This brief summary serves to remind us how hugely important in Europe and America since 1860s was the social and cultural ferment energising the drive towards women's higher education. It was a subject debated in scientific circles, in parliaments and the press, a subject highlighting the opposition, often fierce, of different worldviews, different conceptions of a woman's body and mind (Rowold 2010).

While universities crossed 'from the age of philosophy to the age of science' (Rüegg 2004, p. 16), for the first time in the history of western culture women were a new protagonist in higher education, in the economic market and on the public scene.

5.3 In Italy: The Big Sleep

The panorama outlined above allows us to highlight some interesting aspects of the Italian case, some already touched upon: first, that the access of women to universities in Italy in the 1870s did not occur later than developments elsewhere; secondly, that the women in Italian universities, unlike elsewhere, did not suffer from male closure or rejection, especially in the field of science.

As briefly mentioned above, the first women to graduate in Italy lived within a context of female illiteracy of around 80% in 1870 and around 60% in the early years of the twentieth century (Istituto Centrale di Statistica 1950, p. 183). But it is also true that, despite the strong opposition of some conservative and Catholic sectors of the elites, those few women pioneering quite new social experiences benefited from the liberal climate of the first governments after unification; important politicians and intellectuals demonstrated some by no means banal involvement in the issue (Moretti 1989). When in 1876 new university regulations were introduced, the law stated that "Women may be enrolled in the register of students and auditors, where they present the required documentation", without needing to abrogate previous legislation (Ministero della Pubblica Istruzione 1876, p. 12). However, one of the (many) problems women had to surmount for many decades was to overcome the prejudice that the joint presence of both sexes in secondary schools was dangerous (Raicich 1989; Polenghi 2008; Soldani 2010). Unlike other countries, Italy lacked the spirit of initiative leading to the foundation of private schools for girls that could offer that 'classical' education the *licei* or grammar schools provided, and which opened the doors to every kind of faculty. This meant that between 1877 and 1900, when the number of male graduates oscillated every year between 2000 and 3000 (Cammelli and Di Francia 1996), 224 women graduated (Ravà 1902). With reference to the small numbers of that first generation of women graduates, one fact stands out: 73 of them (32%), almost one graduate in three chose to graduate in sciences or in medicine (27 women graduated in natural sciences; 22 in medicine; 19 in mathematics; two in physics; two in chemistry; one in chemistry and pharmacy). If placed in the context of the history of science, these are interesting figures (Govoni 2009a).

The international debates on women reported in the press played a role in Italy in attracting the first young women to higher education. In the 1880s the middle and upper middle classes were a small percentage of the population (Meriggi 1993), but they did make up a public particularly interested in scientific subjects, including those from beyond the Alps. Clearly, the first wave of women aiming at a new social role and enrolling in a university in Italy showed that they were less influenced by the well-known science literature emphasizing the poor intellectual abilities of women (Babini et al. 1989; Gibson 1990) than by the powerful image of science spread sometimes by those same popularizing scientists in the period of 'science for all': (Govoni 2009b and 2013). It was the national and international context favourable to the sciences and the consequent success of so-called popular science that, in the second half of the nineteenth century in Italy, contributed to women choosing to enrol in increasing numbers for scientific or medical degrees. And in actual fact, the scientific results of women researchers were highly thought of internationally. If we exclude American and English women, who, on their own, account for around two-thirds of the scientific articles published by women and registered in the *Catalogue of Scientific Papers* of the Royal Society, Italian women were the most productive among women scientists of other countries (with 27 % of the publications), including France (24 %), Germany (15 %), Sweden (8 %), and others (data in Creese 2004, p. 209).

Almost all the women of the first generation of women graduates in science in Italy managed significant professional achievements, sometimes excellent. Almost all published papers and books, and one aspect stands out above all: four of the first generation of women science graduates (33 overall) became full professors in an institution of higher education; in 1890 Evangelina Bottero (physics) and Carolina Magistrelli (natural sciences) at the Rome Royal Institutes of Female Higher Education (the 'Magistero'); in 1911 Rina Monti (zoology and comparative anatomy) at the University of Pavia; in 1917 Maria Bakunin (chemistry) at the Naples Polytechnic (Govoni 2006; Babini and Simili 2007). The behavior of male scientists to the first wave of women in scientific faculties in Italy was characterised by a relatively welcoming attitude.

To understand the Italian situation in this period (1880s to First World War), I have found it useful elsewhere to compare the Italian case with the British one (Govoni 2013). Of course, many Victorian men of science, some for 'scientific' reasons, others for 'ethical' ones, were firmly opposed to women entering universities and professional scientific societies. An important literature has explored this, including the various and complex positions of the Darwinians on woman's place in science and society (Dyhouse 1976; Russett 1989; Richards 1983, 1997; Kohlstedt and Jorgensen 1999; for further bibliography, see Rowold 2010). In the United Kingdom the pressure from women to enter the university and professional societies coincided with the decisive stages in the evolution of natural philosophers into scientists, a self-aware group that recognized in the 'the new woman' a potentially dangerous competitor. To put it briefly, the 'mulish prejudice' (McWilliams Tullberg 1998, p. 1) towards the entry of women into the universities was also the reaction of a professional group caught up in its own definitive affirmation in the public as well as in the political and economic sphere. Institutions like universities of ancient and 'sacred' traditions, and other newer ones, like the professional societies, felt they had to remain places of excellence for (male) adepts (for a well-known example, see Huxley to Lyell, March 17, 1860, in Huxley 1901, p. 228).

The temporary prevailing of 'professional' motives over 'scientific' or 'ethical' ones (very important as these obviously were), which was behind the men of science's rejection of women in United Kingdom, helped me understand the apparently odd nature of the Italian case. Quantitative and prosopographic data (Govoni 2009a, *Scienza a Due Voci* web site) for the experiences of the first generation of women science graduates demonstrate that the scientists they had to do with showed no hostility towards them, but on the contrary in some cases actually encouraged their studies and professional activities.

In Italy, the reason for the collaboration between men and women in science in the Liberal age did not simply lie in the tiny number of women science graduates and in the enlightened attitude of the first generation of scientists in unified Italy. As confirmed by a great many and varied indicators, that generation of scientists had worked in a situation in which a national community of experts did not yet really exist (for overviews, see Casella et al. 2000; Cassata and Pogliano 2011). Italian scientists were few, and scattered throughout numerous universities, and the weakness of their community was also shown by their inability to perceive the threat from women graduates in science as possible competitors: most scientists did not realise that women in science were no longer ‘exceptions’, but the first signs of a new social phenomenon. I think this is confirmed if we compare the different behaviour of doctors and lawyers in this period; these two categories, for centuries both powerful and cohesive, with consolidated economic interests outside the walls of the university, for a very long time made entry into their medical and legal professions extremely difficult for women in Italy (Vicarelli 2008; Tacchi 2009).

5.4 From 1900 to the Second World War

Whereas many of the first women graduates in science in Italy attained important professional achievements, the general situation of women in education in the country improved only very slowly. In the academic year of 1914–15 there were 1486 women enrolled in universities: 5.6% of students overall (from data in Ministero della Pubblica Istruzione 1923, p. 203, 205). And yet despite the numerous invitations to act from a variety of sectors, not just female, concrete support for a *liceo* (grammar school) education favouring women’s enrolment in universities was still lacking. At the end of the First World War the number of girls in grammar schools was still very low: in the school year of 1919–20 people leaving with the necessary diploma of *liceo* were 4685, and the girls 932; the girls leaving with certificates from the technical secondary schools (whose diploma enabled enrolment in science faculties) were 1227, whereas the boys were 5905 (Ministero dell’Economia Nazionale 1924–1925, p. 134). As a result the increase in the proportion of women’s degrees was slow; in the decade 1901–1910 women graduates had been 5% of graduates, from 1911–1920 they were 8% (Istituto Centrale di Statistica 1976, p. 56). Nevertheless, that increase was quite considerable compared to the past, and in 1918 this fact did not escape Giovanni Gentile (1875–1944), the internationally well-known idealist philosopher who would be Minister of Education in the first Mussolini government. According to Gentile, there was a trend towards the abandonment of a career in teaching on the part of men, so schools would soon be quickly “invaded by women, which have now flooded into our universities, and which, it has to be said, do not possess and never will […] originality of thought”. (Gentile 1919, p. 8).

As in other countries caught up in the Great War, women in Italy demonstrated a new vitality in many professional sectors (among others: De Grazia 1992; Curli 1998; Scardino Belzer 2010). Within universities, the trend soon became evident. In the academic year 1921–22 the men enrolled in courses for a degree in the humanities were 1547 and the women 1300 (the male graduates of those courses that year were 223, the women 145), the next academic year the women enrolled in those same courses were 1387 and the men had dropped to 1257 (the male graduates 293, the women 173). That same academic year, there were 395 women enrolled in the university courses of mathematics, physics and natural sciences to obtain the degree in 'pure mathematics', while the men were 386. In the courses for the degree in 'physical-mathematics' the women were 131 and the men 35, and for the degree in natural sciences the women enrolled were 214 and the men 207 (Presidenza del Consiglio dei Ministri 1926, p. 97–99). Whereas the number of male graduates overall continued to be much higher than that of women graduates, the increase in women's enrolment demonstrated their strong interest in higher education.

Of special interest in these years is the watershed that occurred in the academic year 1923–24: the number of women obtaining a degree in science, medicine and pharmacy totalled 522, and women graduates in the humanities 492, including those with the diplomas from the two *Magisteri* and "other" (Table 5.1). This happy situation for the relationship between women and science in the universities was never to recur.

The number of women graduates in science faculties grew until the academic year 1923–24, when it reached a peak, and then fell (Fig. 5.2).

This phenomenon leads us to examine the influence of positivist propaganda in favour of science, which continued in the schools until after the First World War, as in popular publications. On the other hand, a role was certainly played by the impulse the First World War gave to scientific research, especially chemistry, which nevertheless, as far as women are concerned, still has to be explored. The data would seem to indicate that between the two wars the choices of the women studying at university were conditioned by the national and international cultural climate, which was spread through the press and publications, rather than the supply of work available in the labour market: until the First World War there was the influence of Positivism, with its emphasis on science as the culture of 'progress'; after the war neo-idealism tended to prevail, leading in the public sphere to a new image of the humanities, especially philosophy, as the most suitable tool for science in the search for 'truth'.

An episode occurring at that time would seem to confirm this interpretation. In line with the thinking of Gentile quoted above, in 1926 new Fascist regulations for competitive state examinations to obtain a post in secondary schools excluded women from taking the examinations for posts of Greek, Latin, Italian, history, and philosophy in the *licei*, the technical schools and in those for training teachers (Art. 11 del R.D. 9 dicembre 1926, n. 2480, "Gazzetta Ufficiale", 29 marzo 1927, n. 73). If the shift of women from one kind of faculty to another was determined in the first place by the job opportunities offered by schools, an area where women were a very significant presence, as Gentile had noted, then the data from 1926–27 should really demonstrate a contrary trend, i.e., a considerable fall in enrolment in courses of the humanities, and an increase in those of the sciences. But a recovery in the numbers of women graduates in science faculties took place only toward the second half of the 1930s and in particular with the Second World War, in a climate

Table 5.1 Women with degrees and diplomas in higher education, 1913–1941. (Data of the Istituto Nazionale di Statistica [National Institute of Statistics], in Govoni 2009a, p. 229)

	Law	Economics	Humanities	Magistero	Oriental studies	Medicine	Science	Pharmacy	Other	Total
1913–14	4	5	63	57		22	60	21	3	235
1918–19	7	8	164	119		17	123	23	1	462
1923–24	30	38	258	226		27	330	165	8	1082
1929–30	75	48	469	199	20	53	226	290	13	1393
1933–34	96	71	490	303	79	101	210	312	22	1684
1938–39	65	91	909	560	62	97	221	254	31	2290
1941–42	45	110	1140	1081	88	54	303	161	30	3012

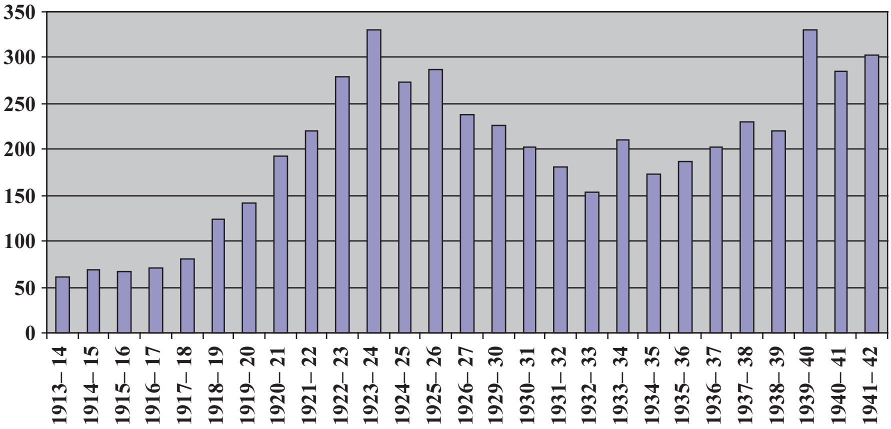

Fig. 5.2 Woman graduates in science, Italy, 1913–1942, absolute values. (From data of the Istituto Nazionale di Statistica [National Institute of Statistics], in Govoni, 2009a, p. 234)

that saw an all-round increase in enrolment. In the decade 1931–1940 women were 17 % of the graduates (Istituto Centrale di Statistica 1976, p. 56). That return to a growth in enrolment in science courses meant that whereas in the academic year 1936–1937, the science graduates numbered 569 overall, of whom 194 were women (34 %), in the academic year 1939–1940 the science graduates rose to 1145, of whom 331 were women (29 %) (Istituto Centrale di Statistica 1941, p. 298).

On the number of women teaching in the universities there was something of a halt compared to what had been achieved by the first generations of women graduates in science. I have argued that it was because of the late formation of a national community of scientists that the latter were late in realizing that women in science could be competitors. Things changed after the First World War. Women ‘flooded’ into the universities, while with their participation in wartime research, Italian scientists had achieved the construction of a community of professionals in technological and scientific research which in other countries had already long been consolidated (Maiocchi 2000; Simili and Paoloni 2001; Pancaldi 2006; Tomassini 2011). In those same years the posts available in universities through state competition increased in the natural sciences (Dröscher 2013). It was at this point in the science faculties, that the control exercised by influential scientists in positions of power over women’s access to posts, developed.

In Fascist Italy no laws preventing women from going to university were passed, although this happened in other areas of the public sector as well as in schools (Ballestrero 1996). And yet, the quantitative data on the presence of women in university teaching, the few cases reconstructed, and others now being studied, show that other similarly effective ways could be found by academics—not by Fascist laws—to get them out of higher education. In 1931 the percentage of women graduates in science out of a total of graduates in science, male and female, was 34 %, but women made up only 0.87 % of science and medicine university teachers (data from the Istituto Centrale di Statistica del Regno d’Italia 1936, pp. 74–75).

In Fascist Italy in the 1920s and 1930s there was a backlash that recalls what was happening in more democratic countries like United Kingdom and the United States (Rossiter 1982, p. 122, 190–193, 269–270; Dyhouse 1995, p. 138). There, the backlash has been read as the result of the advances made by women in the first decades of the century. I think the Italian case, too, should be read in the context of the increasingly competitive relations between men and women inside the universities, as may also be seen from the autobiographical evidence of some of the main actors of the science of the time (Fermi 1954).

5.5 From the Cold War to the Present

In Italy throughout the fifties the number of women graduates continued to be far lower than men: in the academic year 1950–1951, 25-year-old women with a degree were 1.5 % of the population, whereas men of the same age made up 3.4 %; ten years on (1960–1961), the percentage of 25-year-old women with a degree was still only 1.7 % of the population, whereas for men it was 3.7 %. The enrolment of women en masse in universities occurred toward the end of the sixties: by 1970–1971, 7.2 % of 25-year-old women had a degree. Between 1960–1961 and 1970–1971, the women enrolled in universities increased by 255.1 %: the premise for the overtaking of men by women in 1990–1991 (Fig. 5.1; Istat 2001, p. 13, 15).

Concerning their cultural choices, in the 1950s the number of women students choosing to study a scientific subject remained conspicuously high, continuing the trend we have seen beginning in the second half of the 1930s. But with the increase of women's enrolment in the years 1960–1970 there was a dramatic drop in the percentage for science faculties, a drop that for men occurred in the 1980s. While in the academic year 1950–1951 31.9 % of women students were enrolled in a science faculty, in the academic year of 1997–1998 there were only 12.2 % (Fig. 5.3).

In recent years women's enrolment in science and technology has picked up again, and at present those enrolled in the scientific and technical sector are 18.5 % of the women enrolled (Miur 2011, p. 47). To this increase should be added the success achieved by women in the PhD sector, a higher level only introduced in Italy as late as 1982. In 2005 the women made up 50.9 % of those with new doctorates, peaking at 72.40 % in biology, 61.50 % in medical sciences, 59.40 % in chemistry, 52.20 % in agricultural sciences, 50 % in earth sciences, and 48.90 % in civil engineering and architecture (Miur 2008, p. 52). The number of women in a PhD course continues to increase, and in 2008–2009 made up 52.9 % of the whole (Miur 2011, p. 63).

The extraordinary success rate of women graduates and postgraduates is borne out by the qualitative results achieved, as women obtain better marks and take less time to finish their studies than men. Nevertheless, the situation of women university teachers and researchers has not improved in proportion to the success rate of the women graduates and women with PhDs. In 2005 women made up 17.5 % of the professors, 32.5 % of the associate professors, and 44.7 % of assistant profes-

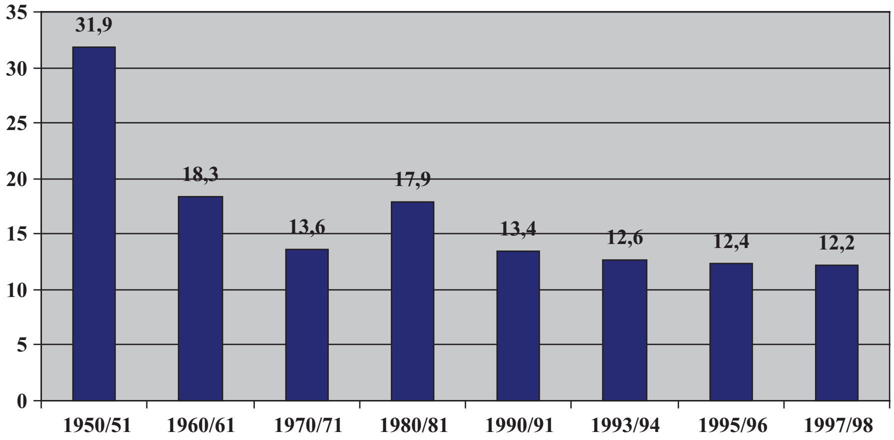

Fig. 5.3 Percentage of women enrolled in the science sector compared to the total of female enrolments, 1950/1951–1997/1998. (From data of the Istituto Nazionale di Statistica [National Institute of Statistics], in Govoni 2009a, p. 233)

sors. Over the last five years the increase has been minimal: according to the latest available data (at 31/12/2011), women make up 20.6 % of the professors, 34.2 % of the associate professors, and 45.2 % of the assistant professors. In some of the scientific sectors, this is the situation for full professors: in biological sciences women form 41.6 %, in chemical sciences 25.9 %, in medical sciences 14.7 %, in physics 9.9 %. Many feel that without the introduction of affirmative action or a network of 'watchdogs', this situation of teaching staff ratios will not improve, taking into account women student success rates, as the case of women in the humanities also shows. In the latter sectors, the number of women graduates in Italy overtook the men by the 1940s. Despite this, in the macro-sector called Philosophical, historical, pedagogical and psychological sciences, only in the role of assistant professors do women attain 51.9 %, whereas they are 31.9 % of the associate professors, and 31.4 % of the full professors (data Miur at 31/12/2011; the latest data at http://statistica.miur.it/scripts/personalediruolo/vdocenti1.asp).

What is happening now, in my opinion, is that the women teaching staff in Italian universities are having to challenge the second, most tenacious backlash since the1920s, when women in universities first began to represent a visible percentage in official statistics.

Conclusions

Although since the 1970s Italy is supposed to be one of the seven most 'advanced' industrialized countries of the planet, international rankings unhappily indicate Italian universities' woefully inadequate performance. If we take the long-term view of the data, as I have been doing here, there is one indicator running totally counter to this worrying trend: women. As the graph in Fig. 5.1 shows, the number of women at university, virtually invisible until 1920, increased considerably with the Second World War, surged significantly towards equality between the end of the sixties and the seventies, and caught up with men in the academic year 1990–1991. The increase in women students continues, despite the overall recent drop in enrolment, confirming a strong social trend: we are probably dealing with the most important of the university successes in the last century. Behind the quantitative data is concealed a potential, in terms of cultural innovation, that is underutilized and undervalued.

As far as the progress over the years of the relations between women and science goes, both the increase and the sometimes sharp drop in the number of women enrolling in science faculties that we have noticed (leaving aside those effects linked to the world wars to which specific consideration should be given), seem to follow upon circumstances that recur. Rather than the supply of work provided by the labour markets, the international cultural fashions, which in various eras have known how to win room in the press and publications in general, would seem to have had a role in the choices women make. This happened in the decades after unification, during the so-called age of science, which coincided with the women's first entry into the university. Of the first generation of women graduates almost one in three chose to graduate in sciences or in medicine (32%). In the years of the success of 'science for all' many reforms were carried out in Italy, both in popular and in higher education, which attracted the media's attention to the subject. Although no one ever asked women to go in for the sciences at university, the few of them who did were evidently responding positively to a general milieu that cared about the subject of education, and at the same time looked favourably on the sciences. Here I have argued that, unlike what happened in more advanced countries from a science perspective, it was because of the late formation of a national community that (male) Italian scientists were late in realizing that women in science could be real competitors.

A second interesting phase in the history of the relationship between women and science goes from the Great War to the early 1920s: in that period the number of women graduates in science reached its highest peak of the first half of the century. In the academic year 1923–1924 the women graduates in sciences, medicine and pharmacy overtook those in the humanities, something never to be repeated. In the years that followed, however, women's professional achievements in the university did not improve. I suggest that the tragic political events in Italy from the 1920s onward can explain only in part the downs in the relationship between men and women in (science) higher education between the wars. That negatively evolving relationship coincided with the definitive building of a national science community now aware that women were actually competitors in the universities. Women's disaffection with the sciences was produced between the second half of the twenties and throughout the thirties, when the myths of 'progress' forged by science and technology were substituted all over Europe by others, often of a neo-idealist and spiritual tendency. The press and publications generally gave ample room to the new cultural trends, as they did to the reforms being carried out in the educational sector (Galfré 2000). During the Second World War women returned to the scientific faculties and maintained good relations with them until the 1950s.

Yet a third synergy, once again negative for the sciences, appeared between the end of the 1960s and the early 1970s. The Cold War was at its height and the climate was everywhere hostile to science and scientists, especially among young people and feminist movements. In the 1960s and 1970s, while the overall number of women graduates grew exponentially, the number of those enrolled in science faculties dropped in a proportionately significant way. In this case, too, a synergy seems evident between cultural events, national and international, feminist and young people's movements, both strongly critical of science, and interventions in Italy in the field of education: the reform of the secondary school which opened the gates of the university also to students from technical and vocational training schools (1969), and the following birth of the so-called 'mass' university (Statera 1977; De Masi 1978, pp. 49–51; Franchi et al. 1987). Those events created a great stir in the media.

That cultural reasons prevailed over economic ones in women's choice of faculty in Italy would seem to be confirmed by the generally low number of women in the labour market compared to other European countries. In recent years this alarming phenomenon has attracted the attention of economists. In the search for possible solutions, new studies have focused on the gender relationships in the family and in Italian society, and how these may affect the propensity of women to hesitate over entering the labour market, as well as the resulting social and economic costs of the phenomenon (Del Boca et al. 2012). A context in which a woman graduate, even with a PhD, more often than elsewhere is faced with poor career prospects, or none at all, could be one of the (many and complex) reasons still leading many young women to choose the humanities instead of scientific and technical subjects; in addition, the latter studies may seem more the prelude to careers held to be incompatible for women with the management of a family.

Qualitative research will enable us to enquire more thoroughly into the cultural and scientific, as well as the social and institutional, implications that the quantitative relations between men and women in the university have had in the twentieth century. Despite the backlashes, since the last decades of the nineteenth century the history of universities has been a history of men and women.

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References

Abir-Am, Pnina G. 2010. Gender & technoscience: A historical perspective. *Journal of Technology Management & Innovation* 5:152–165.

Babini, Valeria P., and Raffaella Simili, eds. 2007. *More than pupils: Italian women in science at the turn of the twentieth century*. Florence: Olschki.

Babini, Valeria P., Fernanda Minuz, and Annamaria Tagliavini. 1989. *La Donna nelle Scienze dell'Uomo*. 1st ed. 1986. Milan: Angeli.
Ballestrero, Maria Vittoria. 1996. La Protezione Concessa e l'Eguaglianza Negata. In *Il Lavoro delle Donne,* ed. Angela Groppi, 445–469. Rome: Laterza.
Bensaude-Vincent, Bernadette, and Anne Rasmussen, eds. 1997. *La Science Populaire dans la Presse et l'Édition: XIXe et XXe Siècles*. Paris: CNRS.
Brock, Michael G., and Mark C. Curthoys, eds. 2000. *Nineteenth-century Oxford, Part 2, The history of the University of Oxford*. Vol. 7. Oxford: Clarendon Press.
Bryant, Margaret. 1979. *The unexpected revolution. A study in the history of the education of women and girls in the nineteenth century,* foreword by Asa Briggs. London: University of London, Institute of Education.
Cammelli, Andrea, and Angelo Di Francia. 1996. Studenti, Università, Professioni: 1861–1993. *I professionisti. Storia d'Italia. Annali 10,* ed. Maria Malatesta, 8–77. Torino: Einaudi.
Casella, Antonio, Alessandra Ferraresi, and Giuseppe Giuliani, eds. 2000. *Una Difficile Modernità. Tradizioni di Ricerca e Comunità Scientifiche in Italia 1890–1940*. Pavia: Goliardica Pavese.
Cassata, Francesco, and Claudio Pogliano, eds. 2011. *Scienze e Cultura dell'Italia Unita*, *Storia d'Italia. Annali 26*. Turin: Einaudi.
Cavazza, Marta. 2009. Women and science in enlightenment Italy. In *Italy's eighteenth century. Gender and culture in the age of the grand tour,* eds. Paula Findlen, and Catherine M. Sama, 275–302. Stanford: Stanford University Press.
Cavazza, Marta. Forthcoming. Women readers of Newton. In *The reception of Isaac Newton in Europe,* ed. Scott Mandelbrote and Helmut Pulte, vol. 2. London: Continuum.
Christen-Lécuyer, Carole. 2000. Les premières étudiantes de l'Université de Paris. *Travail, genre et Société* 4:35–50.
Cipolla, Carlo M. 1969. *Literacy and development in the West*. Harmondsworth: Penguin.
Creese, Mary R. S. 2004. *Ladies in the laboratory II: West European women in science, 1800–1900. A survey of their contributions to research*. Lanham: The Scarecrow Press (with contributions by Thomas M. Creese).
Curli, Barbara. 1998. *Italiane al lavoro, 1914–1920*. Venezia: Marsilio.
Davis, John A., ed. 2000. *Italy in the nineteenth century, 1796–1900*. Oxford: Oxford University Press.
De Fort, Enrica. 1995. *Scuola e analfabetismo nell'Italia del '900*. Bologna: Il Mulino.
De Giorgio, Michela. 1992. *Le italiane dall'Unità a oggi*. Bari-Rome: Laterza.
De Grazia, Victoria. 1992. *How fascism ruled women: Italy, 1922–1945*. Berkeley: University of California Press.
De Masi, Domenico. 1978. *Dentro l'università. Studenti, classi, corporazioni*. Milano: Angeli.
De Mauro, Tullio. 2011. *Storia linguistica dell'Italia unità*. 1st ed. 1963. Laterza: Roma.
Del Boca, Daniela, Letizia Mencarini, and Silvia Pasqua. 2012. *Valorizzare le donne conviene. Ruoli di genere nell'economia italiana*. Bologna: Il Mulino.
Dröscher, Ariane. 2013. *Le facoltà di scienze matematiche, fisiche e naturali in Italia (1860–1915). Repertorio delle cattedre e degli stabilimenti annessi, dei docenti, dei liberi docenti e del personale assistente e tecnico*. Bologna: CLUEB.
Durham, Martin. 1998. *Women and fascism*. London: Routledge.
Dyhouse, Carol. 1976. Social darwinist ideas and the development of women's education in England, 1880–1920. *History of Education* 5 (1): 41–58.
Dyhouse, Carol. 1995. *No distinction of sex? Women in British Universities, l870–l939*. London: Routledge.
European Commission (EC). 2009. She figures 2009. Statistics and indicators on gender equality in science. http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2009_en.pdf. Accessed 12 Nov 2013.
European Commission (EC). 2012. Preliminary results of she figures 2012. http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2012_en.pdf. Accessed 13 Nov 2013.

Fermi, Laura. 1954. *Atoms in the family. My life with Enrico Fermi*. Chicago: Chicago University Press.

Findlen, Paula. 1993. Science as a career in enlightenment Italy: The strategies of Laura Bassi. *Isis* 84: 441–469.

Findlen, Paula. 1995. Translating the new science: Women and the circulation of knowledge in Enlightenment Italy. *Configurations* 2: 167–206.

Franchi, Giorgio, Barbara Mapelli, and Giovanni Librando. 1987. *Donne a scuola. Scolarizzazione e processi di crescita di identità femminile negli anni '70 e '80*. Milan: Angeli.

Fyfe, Ayleen, and Bernard Lightman, eds. 2007. *Science in the marketplace: Nineteenth-century sites and experiences*. Chicago: University of Chicago Press.

Galfré, Monica. 2000. *Una riforma alla prova. La scuola media di Gentile e il Fascismo*. Milan: Angeli.

Gavroglu, Kostas, et al. 2008. Science and technology in the European periphery: Some historiographical reflections. *History of Science* 46:153–175

Gentile, Giovanni. 1919. *Il problema scolastico del dopoguerra*. Naples: Ricchiardi.

Gibson, Mary. 1990. On the insensitivity of women: Science and the woman question in liberal Italy, 1890–1910. *Journal of Women's History* 2:11–41.

Golinski, Jan. 2005. *Making natural knowledge. Constructivism and the history of science,* with a new preface. 1st ed. 1998. Chicago: Chicago University Press.

Gouzévitch, Dimitri, and Irina Gouzévitch. 2000. The difficult challenger of no man's land or the Russian road to the professionalization of women's engineering (1850–1920). *Quaderns d'Història de l'Enginyeria* 4:133–183.

Govoni, Paola. 2006. Donne e scienza nelle università italiane, 1877–2005. In *Storia, scienza e società. Ricerche sulla scienza italiana in età moderna,* ed. Paola Govoni, 239–288. Bologna: Bologna Studies in History of Science, 11, CIS, Università di Bologna.

Govoni, Paola. 2009a. 'Donne in un mondo senza donne'. Le studentesse delle facoltà scientifiche in Italia, 1877–2005. *Quaderni Storici* 130:213–248.

Govoni, Paola. 2009b. The historiography of science popularization: Reflections inspired by the Italian case. In *Popularizing science and technology in the European periphery, 1800–2000,* eds. Faidra Papanelopoulou, Agustí Nieto-Galan, and Enrique Perdriguero, 21–42. Aldershot: Ashgate.

Govoni, Paola. 2013. The power of weak competitors: Women scholars, 'Popular science' and the building of a scientific community in Italy, 1860s–1930s. *Science in Context* 3:405–436.

Heilbron, John L., J. Bartholomew, J. Bennett, F. L. Holmes, R. Laudan, and G. Pancaldi, eds. 2003. *Companion to the history of modern science*. Oxford: Oxford University Press.

Huxley, Leonard, ed. 1901. *Life and letters of Thomas Henry Huxley*. Vol. 1. New York: Appleton.

Istat. 2001. *Donne all'università*. Bologna: Il Mulino.

Istituto Centrale di Statistica. 1941. *Annuario Statistico Italiano, anno 1941*, XIX, quarta serie. Vol. 8. Rome: [s.n.].

Istituto Centrale di Statistica. 1950. *Dati retrospettivi. Annuario statistico dell'istruzione italiana, 1947–48*, serie I, vol. 1, 1950. Rome: [s.n.].

Istituto Centrale di Statistica. 1976. *Sommario di statistiche storiche dell'Italia, 1861–1975*. Rome: [s.n.].

Istituto Centrale di Statistica del Regno d'Italia. 1936. *Statistiche intellettuali. Statistica dell'istruzione superiore per l'anno accademico 1931–32 e notizie statistiche per gli anni accademici dal 1927–28 al 1930–31*. Vol. 11. Rome: Tip. Failli.

Keller, Evelyn Fox. 1985. *Reflections on gender and science*. New Haven: Yale University Press.

Kohlstedt, Sally Gregory, and Mark R. Jorgensen. 1999. 'The irrepressible woman question': Women's responses to evolutionary ideology. In *Disseminating Darwinism: The role of place, race, religion, and gender,* eds. Roland L. Numbers and John Stenhouse, 267–293. Cambridge: Cambridge University Press.

Lange, Helene. 1890. *Higher education of women in Europe.* Translated and accompanied by comparative statistics by L. R. Klemm. 1st ed. (Berlin 1888). New York: Appleton.

Maiocchi, Roberto. 2000. L'organizzazione degli scienziati italiani. In *Gli intellettuali e la Grande guerra,* eds. Vincenzo Calì, Gustavo Corli, and Giuseppe Ferrandi, 209–244. Bologna: Il Mulino.

Mazón, Patricia M. 2003. *Gender and the modern research university. The admission of women to German higher education, 1865–1914*. Stanford: Stanford University Press.

Mazzotti, Massimo. 2007. *The world of Maria Gaetana Agnesi, mathematician of God*. Baltimore: Johns Hopkins University Press.

McWilliams Tullberg, Rita. 1998. *Women at Cambridge*. Cambridge: Cambridge University Press.

Meriggi, Marco. 1993. The Italian *Borghesia*. In *Bourgeois society in nineteenth-century Europe,* eds. Jurgen Kocka and Allan Mitchell, 423–438. Oxford: Berg Publishers.

Messbarger, Rebecca. 2010. *The lady anatomist: The life and work of Anna Morandi Manzolini*. Chicago: Chicago University Press.

Ministero della Pubblica Istruzione. 1876. Nuovi Regolamenti Universitari. *Bollettino Ufficiale. Ministero della Pubblica Istruzione,* vol. II, n. XII, gennaio.

Ministero della Pubblica Istruzione. 1923. *Gli Studenti delle Università Italiane. Indagini statistiche. Bollettino Ufficiale del Ministero dell'Istruzione Pubblica, Supplemento al n. 59 del 31 dic. 1923*. Roma: Tip. Operaia romana coop.

Ministero dell'Economia Nazionale, Direzione Generale della Statistica. 1924–1925. *Annuario Statistico Italiano, seconda serie, vol. VIII, anni 1919–1921, Indici economici fino al 1924*. Rome: Provveditorato Generale dello Stato.

Ministero Istruzione Università Ricerca (Miur). 2008. *L'università in cifre 2007,* Rome. http://statistica.miur.it/normal.aspx?link=pubblicazioni. Accessed 13 Nov 2013.

Ministero Istruzione Università Ricerca (Miur). 2011. *L'università in cifre 2009–2010,* ed. Claudia Pizzella and Simonetta Sagramora. Rotoform: Rome. http://statistica.miur.it/normal.aspx?link=pubblicazioni. Accessed 13 Nov 2013.

Moretti, Mauro. 1989. Pasquale Villari e l'istruzione femminile. In *L'educazione delle donne. Scuole e modelli di vita femminile nell'Italia dell'Ottocento,* ed. Simonetta Soldani, 497–530. Milan: Angeli.

Moss-Racusin, Corinne A., et al. 2012. Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Science of the United States of America* 109 (41): 16474–16479.

Newcomer, Mabel. 1959. *A century of higher education for American women*. New York: Harper & Brothers Publishers.

Noble, David F. 1993. *A world without women: The Christian clerical culture of Western science*. New York: Knopf.

Offen, Karen. 2000. *European feminism, 1700–1950: A political history*. Stanford: Stanford University Press.

Paletschek, Sylvia, and Bianka Pietrow-Ennker, eds. 2004. *Women's emancipation movements in the nineteenth century: A European perspective*. Stanford: Stanford University Press.

Pancaldi Giuliano. 2006. Wartime chemistry in Italy: Industry, the military and the professors. In *Frontline and factory. Comparative perspectives on the chemical industry at War, 1914–1924,* eds. Roy MacLeod and Jeffrey A. Johnson, 61–74. Berlin: Springer.

Papanelopoulou, Faidra, Agustí Nieto-Galan, and Enrique Perdriguero, eds. 2009. *Popularizing science and technology in the European periphery, 1800–2000*. Aldershot: Ashgate.

Polenghi, Simonetta. 2008. 'Missione naturale', istruzione 'artificiale' ed emancipazione femminile. Le donne e l'università tra Otto e Novecento. In *L'altra metà della scuola. Educazione e lavoro delle donne tra Otto e Novecento,* eds. Carla Ghizzoni, and Simonetta Polenghi, 283–318. Turin: Società Editrice Internazionale.

Pomata, Gianna. 2004. Rejoinder to Pygmalion: The origins of women's history at the London School of Economics. *History of Historiography* 46:79–104.

Porciani, Ilaria, ed. 1994. *L'università tra Otto e Novecento: i modelli europei e il caso italiano*. Naples: Jovene.

Presidenza del Consiglio dei Ministri Istituto Centrale di Statistica. 1926. *Annuario Statistico Italiano,* seconda serie, vol. IX, anni 1922–1925. Rome: [s.n.].

Raicich, Marino. 1989. Liceo, università, professioni: un percorso difficile. In *L'Educazione delle donne. Scuole e modelli di vita femminile nell'Italia dell'Ottocento,* ed. Simonetta Soldani, 147–181. Milan: Angeli.

Ravà, Vittorio. 1902. Le laureate in Italia. *Bollettino Ufficiale. Ministero della Pubblica Istruzione* 1 (14): 634–654.

Richards, Evelleen. 1983. Darwin and the descent of women. In *The wider domain of evolutionary thought,* eds. David Oldroyd and Ian Langham, 55–111. Dordrecht: Reidel.

Richards, Evelleen. 1997. Redrawing the boundaries: Darwinian science and Victorian women intellectuals. In *Victorian science in context,* ed. Bernard V. Lightman, 119–142. Chicago: Chicago University Press.

Ringer, Fritz. 2004. Admission. In *A history of university in Europe, vol. III, universities in the nineteenth and early twentieth centuries (1800–1945),* ed. Walter Rüegg, 233–268. Cambridge: Cambridge University Press.

Rossiter, Margaret W. 1982. *Women scientists in America: Struggles and strategies to 1940*. Baltimore: Johns Hopkins University Press.

Rossiter, Margaret W. 1995. *Women scientists in America: Before affirmative action, 1940–1972*. Baltimore: Johns Hopkins University Press.

Rossiter, Margaret W. 2012. *Women scientists in America: Forging a new world since 1972*. Baltimore: Johns Hopkins University Press.

Rowold, Katharina. 2010. *The educated woman: Minds, bodies, and women's higher education in Britain, Germany, and Spain, 1865–1914*. London: Routledge.

Rüegg, Walter. 2004. Themes. In *A history of university in Europe, vol. III, universities in the nineteenth and early twentieth centuries (1800–1945),* ed. Walter Rüegg, 3–31. Cambridge: Cambridge University Press.

Russett, Cynthia Eagle. 1989. *Sexual science. The Victorian construction of womanhood*. Cambridge: Cambridge University Press.

Scardino Belzer, Allison. 2010. *Women and the Great War: Femininity under fire in Italy*. New York: Palgrave Macmillan.

Schiebinger, Londa, ed. 2008. *Gendered innovations in science and engineering*. Stanford: Stanford University Press.

Schirrmacher, Arne, ed. 2013. Communicating science: National approaches in twentieth-century Europe. Special Issue. *Science in Context* 3.

Scienza a Due Voci. University of Bologna. http://scienzaa2voci.unibo.it/. Accessed 13 Nov 2013.

Simili, Raffaella, and Gianni Paoloni, eds. 2001. *Per una Storia del Consiglio Nazionale delle Ricerche*. 2 vols. Bari: Laterza.

Soldani, Simonetta. 2010. *Chequered routes to secondary education: Italy*. In *Girls' secondary education in the Western world: From the 18th to the twentieth century,* eds. James C. Albisetti, Joyce Goodman, and Rebecca Rogers, 59–76. New York: Palgrave Macmillan.

Soldani, Simonetta, and Gabriele Turi, eds. 1993–1996. *Fare gli italiani. Scuola e cultura nell'Italia contemporanea*. 2 vols. 1: 1993; 2: 1996. Bologna: Il Mulino.

Statera, Gianni, ed. 1977. *Il destino sociale dei laureati dell'università di massa,* 2 vols. Naples: Liguori.

Tacchi, Francesca. 2009. *Eva togata. Donne e professioni giuridiche in Italia dall'Unità a oggi*. Turin: Utet.

Tikhonov, Natalia. 2002. Student migrations and the feminisation of European Universities. *Clio. Actes de l'Histoire de l'Immigration*. http://barthes.ens.fr/clio/revues/AHI/articles/english/tiko.html. Accessed 13 Nov 2013.

Tomassini, Luigi. 2011. Guerra, Scienza e Tecnologia. In *Scienze e Cultura dell'Italia Unita*, *Storia d'Italia, Annali 26,* eds. Francesco Cassata and Claudio Pogliano, 103–128. Turin: Einaudi.

Vicarelli, Giovanna. 2008. *Donne di medicina. Il percorso professionale delle donne medico in Italia*. Bologna: Il Mulino.

Willson, Perry. 2009. *Women in twentieth century Italy*. Basingstoke: Palgrave Macmillan.

Zamagni, Vera. 1997. *The economic history of Italy, 1860–1990. Recovery after Decline*. 1st ed. 1993. Oxford: Clarendon Press.

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Chapter 6
The University of Strasbourg and World Wars

Pierre Laszlo

The University of Strasbourg was a key trophy during the wars between France and Prussia/Germany of 1870 and 1914–1918. This account focuses on the following interwar period, 1919–1940, when the university returned to being French; and on the subsequent German occupation of France, when its faculty and students found temporary shelter in Clermont-Ferrand, central France.

For the sake of being concrete and specific, I shall examine the questions of regional, linguistic and academic values through a mini-historical lens, that of the French chemistry faculty at the University of Strasbourg, with its achievements, with also the constraints and the ordeals it faced between the reopening as a French university and 1920 and the return to Strasbourg in 1944, when another reconstruction had to take place.

6.1 A Regained Prestigious Institution

The University of Strasbourg was founded in 1621. After the defeat of France by Prussia in 1870, the whole of Alsace including Strasbourg, its capital, was annexed to the newly constituted Bismarckian Germany. The University not only became part of the network of German universities, it was a prized possession through which Germany could assert academic excellence, it became a beacon of scholarship and of innovative contributions to scientific and technical knowledge.

A peace treaty between Germany and France was signed in 1871 in Frankfurt. Alsatians who wanted to remain French nationals had to leave, in order for full Germanization of the Alsace *Land* to proceed. A significant fraction of the population, predominantly from the cities, several hundred-thousands-strong and known in French as *optants* chose emigration.

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Many settled in the Paris area. An Alsatian lobby, with an elite of writers and scientists, bankers and industrialists, came to exist in Paris. It was infused with nostalgia for the lost homeland, with the hope of somehow, someday resettling there (Fauque and Bram 1994).

Some of its leading figures were the Alsatian chemist, Albin Haller (1849–1925), a professor at the Sorbonne, from 1899, when he succeeded Charles Friedel (1832–1899), one of France's leading chemists. Friedel, a professor of chemistry, first at *École des Mines*, later held a chair at the Sorbonne. He devised, jointly with his American post-doc, Dr Crafts, a novel and powerful chemical transformation (Willemart 1949).

Charles Lauth (1836–1913)—Laute, to pronounce his name in the French way—and Paul Schützenberger (1829–1887) were also Alsatian chemists and academics. Lauth founded the *Société française des matières colorantes*, a company manufacturing dyes, in Saint-Denis near Paris. Schützenberger, also a professor of organic chemistry, discovered cellulose acetate (Gautier 1897). Paul Appell (1885–1930) a mathematician, was appointed to a chair at the Sorbonne in 1888. In 1920, he would become *Recteur*, i.e., the chief administrator of l'Académie de Paris, overseeing the Parisian educational system as a whole (Strauss 1980–2007). Charles Andler (1866–1933) was another professor at the Sorbonne. Appointed there in 1908, he was a scholar of Germany and of its culture (not unlike Fritz Stern at Columbia nowadays), a specialist of German socialism, and of the pan-Germanic ideology and of Nietzsche (Finck 1980–2007). Charles Gerhardt (1843–?) was an architect who became responsible for a number of public buildings in Paris, including the renovation of the *Collège de France*. Albert Kahn (1860–1940) was a banker and a philanthropist; he founded the *Archives de la planète*, an impressive collection of autochrome photographs documenting the very diverse people of mankind. He also funded the first chair in human geography at the *Collège de France* (Laszlo 2013). Jacques Hadamard (1865–1963), a relative of Alfred Dreyfus, was a mathematician of the first rank, a professor at l'*Ecole polytechnique*. Emile Durkheim (1858–1917) founded sociology while his nephew Marcel Mauss (1872–1950) founded French anthropology.

At the center of the Alsatian web of such remarkable men, highly important in French higher education and public life, was Lucien Herr (1864–1926). From 1888 on, and during no fewer than 38 years, he was the head librarian at the *École normale supérieure*. In those functions, he would identify the future leaders of French Academia. His was a position of high influence and of network building (Kintz 1980–2007).

During the first two decades of the twentieth century, including the Great War, members of the Alsatian lobby in Paris made plans for the aftermath of a French victory. These plans included restructuring of the University of Strasbourg, once it had returned to the French fold.

At the end in November 1918, First World War, France took back the Alsace province. From having been a German Imperial University, the university in Strasbourg returned to being a French university. As for its former professors and technicians, the scenario played at the end of either war between France and Germany was the same brutal ousting. Expelled members of staff were given some 2 h to leave, allowed only a single suitcase for their personal belongings, and had to walk out bearing the jeering insults of the populace (Strauss 2002).

Faced with the administration of the reconquered province, the French government temporarily appointed Alexandre Millerand (1859–1943), former minister of war, High Commissioner in Strasbourg, responsible for re-establishing the laws of the Republic and for reorganizing the entire public administrative, educational and cultural networks. German as a language was banned from all official acts. French became the only language allowed in public use.

The influential Alsatians in Paris, predominantly Paul Appell, Charles Andler, Lucien Herr, and the aging chemist Albin Haller had in earlier years carefully thought out a proposal for the University of Strasbourg. They formed a committee chaired by Paul Appell. They wanted sufficient material means for the University of Strasbourg to make it attractive to the best professors. They meant it as an institution of international standing, second to none in France. They pushed for cross-disciplinary fertilization rather than having faculties rule over groups of disciplines. They had a visionary outlook; seminars led by scholars of the first-rank would go beyond traditional disciplinary boundaries (Appell 1923).

The authorities, after setting-up a council composed of Charles Andler, former minister of war procurement Albert Thomas and rector Sébastien Charléty, vetoed such a radical new departure. The University of Strasbourg under the French rule had somehow to conform to the standard mold for French universities, even if it was going to retain its high international reputation and thus to become one of the very best French universities.

Imposition of the standard French university mold suffered one exception, though. In giving a new French beginning to the University of Strasbourg, a key feature differentiated it in advance from all other French universities. In application of the 1801 Concordat signed by Napoleon and the Pope, Alsace was exempted from the laws of Republican France regarding the teaching of religion. Accordingly, the University of Strasbourg in 1919, just like its French predecessor prior to 1870, would again include a Faculty of Catholic Theology and a Faculty of Protestant Theology. This alone made the Strasbourg academics feel special with respect to their colleagues in other French universities. To feel special may encourage one to feel superior, a not-unusual mood for academics. It encouraged the university professors in Strasbourg to depart from habits, stereotypes and regulations that were the norm in the rest of France.

They could be relatively bold. The French government indeed faced a contradiction. How could the French higher-education system cope with the necessity of coming-up with a brand-new institution? The obvious solution, cloning, would not ensure the coveted international reputation. The other option was to entrust a carefully picked group of men—and here the advice of the Paris Alsatians was heeded—with this mission, to give them *carte blanche* together with abundant funding. This alternate solution prevailed.

The very geographic distance from Strasbourg to Paris, about 500 km, with the trip by train taking more than 6 h in 1920, bolstered this measure of independence from Parisian directives.

I shall focus now on the renaissance of chemistry and of its teaching at the University of Strasbourg from 1919 on, as a representative example of initiatives which, as we shall see, sprouted also in other segments of the university. But, first, let us state some of the constraints that then applied.

6.2 Anchoring of the University in the Alsace and the Attendant Tensions

The Alsace region occupies the plain of the Rhine River, in-between the twin forested mountainous ranges of *Les Vosges*, to the West, and the Black Forest (*Schwarzwald*), to the East (Juilliard 1965). In 1648, the Treaties of Westphalia had put an end to the 30 Year War. Alsace has been integral part of France since 1681, when Louis XIV captured Strasbourg, the main city. During that period, of more than two centuries, Alsatians became thoroughly French in many respects while retaining a strong regional identity. In terms of the commonplace, they were identified with a delightful strong accent in speech, which Balzac had a great time transcribing in his novel *Le Cousin Pons*. The Alsatian language is part of the family of German languages. The geographic limit between French and German has not changed in more than fifteen centuries. During the whole period 1681–1919, Catholic priests actively defended the Alsatian tongue, especially in teaching children. When Alsace was a part of France, we owe the survival of its own language—more on this topic below—to their militancy against the French State. Within France, Alsatians enjoyed a reputation for being law-abiding people, rather conservative and *bons vivants*, who loved the conviviality of a good meal.

In sociological terms, Alsace was divided into country people and city people. The former were small farmers and vintners, predominantly Catholics, who sent their children to parochial schools. They overwhelmingly spoke Alsatian (Willems 1970). The latter were city types, often Jewish (Russel and Cohn 2013) or Protestant, intent upon maintaining their political hegemony over the peasants in the countryside, whom they considered backwards. French was their language of choice for intellectual thought and discussion, as well as for education.

Three distinct languages coexisted in the Alsace for many centuries and this was an important feature of the region: in addition to German and French, Alsatian, a Germanic language or dialect, spoken under numerous local variations. This last language has its own literature, dating back to 1816 when J.-G. Daniel Arnold of Strasbourg published a comedy in verse. During the German annexation (1870–1919), the dialectal literature provided the population with a means to affirm its Alsatian identity, with the twin goals of resistance to German assimilation and affirmation of the political nostalgia for being part of France (Finck and Stalber 2004).

The Alsace thus showed and still shows a patchwork of linguistic realities, often highly idiosyncratic. To mention a single example, Alfred Kastler (1902–1984), a physicist of Alsatian roots, who spent the better part of his career in Paris, at the *Ecole normale supérieure* and went on to win a Nobel prize, also wrote poetry in German.

Strasbourg was an intellectual center of the first rank during the Renaissance and the Reformation. Because of all the printers in the town—Gutenberg had lived there (Moore 1995)—sciences and their teaching thrived. This was the dominant influence, rather than that of the Reformation (Thibodeau 1976).

The faculties at the University of Strasbourg conformed to a humanistic model, Erasmian and going back to the Renaissance, reflecting the ingrained Rhineland culture (Marsden 1973; Grendler 2004). This culture was rooted in trade in goods (Kisch 1989) and in ideas. Most significantly, Strasbourg professors had a will not to distance themselves from their fellow-citizens, to remain practical and to nourish the intellectual sphere with real-world applications.

One has to invoke at this point the culture, not only of the Alsace, of the entire Rhineland. It goes back to the higher Middle Ages. Trier was then the capital city of the Empire of the West. The Franks, confronted with the pressure from Eastern hordes of Barbars and their regular incursions or invasions, resorted to Roman-like law and order for their political organization.

Much later, to jump to the eighteenth century and prior to the French Revolution, Rhineland enjoyed a large measure of political autonomy. It prided itself on the civil rights of its citizenry. However, at the turn of the nineteenth century, Napoleon—in the spirit of the Convention—forcefully imposed Parisian centralism and French homogenization (Tilly 1966). Although being submerged, the Alsatian distinctive ethical values were not smothered and they have survived to this day.

Can we document the relationship, in Early Modern times especially, between trade in goods and trade in ideas? The Rhineland, inclusive of the Alsace, from prehistoric times was a channel for moving people and goods (Dominian 1915; Martin 2012). Were Alsatians thus, city-dwellers in particular, brought up with an instinct for commercialising in both kinds of enrichment, material goods and ideas (Brophy 2007)? Can the Alsace be reliably compared to both Switzerland and The Netherlands in the general area of education, from primary schools to universities (Badariotti et al. 1995)? Are these the right questions? And what about the family, as the last question I will raise. Family structure in the Alsace, demographers tell us, was of the so-called “complex” type with several adults living under the same roof (Smets 1996). Is it relevant to the peculiar mix of strong tradition and vigorous innovation, which, I submit, was characteristic of Alsatian scientists? This is not the place to answer these questions, only to raise them.

In 1919 when the University of Strasbourg came back under French rule and chemistry was singled out, the Chemistry Institute, inherited from the German Imperial University (Nohlen 1997), irrespective of who was appointed to a chair, had to meet several challenges. They were representative of those which the University had to face as a whole.

The first was indeed linguistic. The French administration ruled that the French language was the only one to be used. For half-a-dozen years, in the *Institut de chimie*, most students grappled to understand a word in their lectures.

The second difficulty was recruitment of the student body. Alsace was predominantly rural and there was very little motivation among its non-urban population for a university degree. Accordingly, administrators and professors of the University of Strasbourg had to seek their students outside of the Alsace. Germany, the obvious geographical choice being out of question, their net was deployed on its entire periphery. Students came to the university, not so much from inland France, as from Belgium, Luxemburg and the entire central European countries, such as Poland, Hungary or Czechoslovakia (Olivier-Utard 2010).

The third difficulty for chemists at the University of Strasbourg was the lack of a significant degree of industrialization in the Alsace. Chemical plants were few and they were distant; Mulhouse, a birthplace of the textile and dyes industry, is in the southern part of the region, far from Strasbourg; nearby is Thann, and Pechelbronn, an oil-exploitation field in the northern part of the region.

Fourth was the problem of academic cooperation and networking. For political reasons, because of the lasting Germanophobia inherited from the Great War, direct contacts with fellow German academics were forbidden. There was a freeze on such interactions. Of course, the University of Strasbourg was a portal on Germanic language and culture. Its professors in various disciplines were acutely conscious of this responsibility, which they did their best to fulfil. Nevertheless, chemists at the University of Strasbourg, and their colleagues in other disciplines, turned instead to the Anglo-Saxon world for contacts and influence. In those days, post-WWI to II, visiting professors and people who would come to deliver a series of lectures were invited from abroad, from Great Britain and the United States. Thus, an Anglo-Saxon influence permeated the University as it sought both to reassert its Frenchness and cut itself off totally from the German sphere of influence.

6.3 Restaffing the Chemistry Institute and Moving into New Areas

As we saw, the Alsatian lobby in Paris had been defeated in its interdisciplinary guiding ideas for a reborn French Strasbourg university. Conversely though, they were given a free rein in the choice of the new professors.

In chemistry, two chairs in organic chemistry were filled in 1920, together with a third professorship in inorganic chemistry (Perdriat 1994). In the former, the occupants were handpicked by Albin Haller and reflected his still-strong influence on French chemistry as a whole. They were two Alsatians; Paul Thiébault Muller (1863–1933), who was 56 and came from Nancy and Henry Gault (1880–1967), who was only 39 and at that time a professor in Caen.

Muller had succeeded Haller at Nancy as the head of a chemical engineering institute, one of the very first in France, when Haller had received a call to Paris, at the

Sorbonne. Muller was a highly competent administrator, an experienced academic. One could bank on his reliability and French patriotism to apply himself to the task of reconstructing a Chemistry Institute—i.e., an entire curriculum, distribution of tasks between the various members of the staff, a widespread search outside of the Alsace for additional students interested in getting a degree in chemistry—with energy and dedication. The choice of Muller was governed by his reliability; he could be counted upon to uphold Albin Haller's vision for chemistry as a discipline.

To balance Muller's appointment, Haller and his friends from the Alsatian lobby in Paris banked on the much younger chemist, Henry Gault, who was the son of Achille Gault, who had supervised Albin Haller's doctorate in Münster (Viel 1994). They counted on Gault and his youth for innovation, thus complementing Muller's more traditional values.

Muller and Gault arrived at the University in 1920. What they found there was the large building of the Chemistry Institute inherited from the former German Imperial University but it was an empty shell, which had to be entirely restaffed. Moreover, not only did it have to be restructured, along French rather than German lines, but it also needed outside connections. Its isolation from the rest of the University, its insularity as a lone building, almost a fortress, and its self-sufficiency also served as a bulkhead partition against interdisciplinarity.

In 1919, there was a university-wide understanding for the newly appointed professors to come-up with teaching programs that would be bold and innovative, that would *train* students in an original and specific manner. Where the German Imperial University had put its emphasis on research and the advancement of knowledge, the French university would switch it to training young minds to enter fields, either new or not yet part of a university curriculum.

Professors Muller and Gault indeed both created new institutions. Muller, who would also become Dean of the Faculty of Sciences until his retirement, started a chemical engineering school that, in due course (1948), would become the *École nationale supérieure de chimie* of Strasbourg. Gault started the *École du pétrole et des moteurs*, a research and teaching institution, the forerunner of the present-day *Institut français du pétrole*.

In a short time, the *École de chimie* became a success with a regular increase in the student body over the years. Henry Gault got the idea for his *Laboratoire* and *École du pétrole* from the local environment with the existence of an oil production center at Pechelbronn. It would provide his students with field trips and with the opportunity to watch oil production from close quarters. It was perhaps not totally fortuitous if other Alsatians, the Schlumberger brothers, Conrad and Marcel, also started their oil prospection company, based on geophysical measurements, in the 1920s (Allaud and Martin 1977). Professor Gault recognized too that in order to recruit students for the *École du pétrole*, he had to cast his net wider than the Alsace proper and recruit from outside the French borders.

Muller and Gault in their separate enterprises were greatly helped by the times. After World War I, the mood in the Alsace was for reconstruction and original reconstruction; it would not suffice to take over what the Germans had left, the French had to outdo the Germans. This was the challenge, and people, as a rule, give their best when thus challenged. The two Alsatian professors of chemistry did not fail to respond and built enduring centers of excellence.

Henry Gault claims our interest for yet another reason. He was a pioneer in France for switching back and forth from academia to industry. In 1925, he left Strasbourg and became director of research of the chemical and pharmaceutical company Société chimique des usines du Rhône, later to be known as Rhône-Poulenc. He returned to Academia in 1931 and to the University of Strasbourg in 1932.

Louis Hackspill (1880–1963) was also appointed professor of chemistry at the University of Strasbourg in 1919. An inorganic chemist, he assisted Paul-Thiébault Muller in running the chemical engineering institute he had started.

The pattern set-up by Muller and, to a larger extent by Gault, not contenting themselves with academic competence and excellence, also jump-starting novel institutes with brand-new disciplinary aims and directions in order to modernize the university and adapt it to the times, was not restricted to chemistry. Examples from other parts of the university illustrate the trend, an overall picture of a vibrant, dynamic and renewed institution.

There was a crying need, after 40 years of hegemony of the German language in the Alsace, for the reintroduction of French. As early as the summer of 1919, series of lectures were set-up to reacquaint primary and secondary school teachers in the Alsace with the French language. This was continued through the years in the shape of an *Institut d'études françaises*.

In geology, Georges Friedel (1865–1933), Charles Friedel's son and a pioneer in the field of liquid crystals, cooperated with Henry Gault in beginning the Petroleum Institute (Friedel 1926).

Edmond Rothé (1873–1942) headed an Institute for Physics of the Globe together with an Institute of Seismology, both active in geophysics. Georges Rempp, who had belonged to the German university, was put in charge of meteorology.

In mathematics, Maurice René Fréchet (1878–1973) reached Strasbourg immediately after the Armistice on January 15 1919, still wearing his uniform. When the university was formally reopened in November 1919, Fréchet stated the desire of France to turn the University of Strasbourg into a showcase of the reconstruction of the Alsace. It would not be enough to make it the equal of, say, the University of Lyon, in maths, he meant for Strasbourg to reach the top among French universities, second only to Paris. When in 1919 he expressed this ambition, Fréchet had already achieved it numerically. The teaching staff in the Mathematical Institute already outnumbered the total of ordinary, extraordinary professors and privat-dozents in the former German university. In his Institute, Fréchet put the emphasis on teaching, based on complementarity between formal lectures and exercise sessions. An initiative of his, representative of the mood in the new university as a whole, served to both bridge the "town–gown" divide and to encourage applied science. Just as the chemists had set-up, outside pure chemistry, a Petroleum Institute, Fréchet started teaching classes, jointly with the sociologist Maurice Halbwachs (1877–1945), who had been appointed to the first chair of sociology to be set at a French provincial university, at the Strasbourg Chamber of Commerce. They dealt with the application of statistical techniques to social phenomena. There ensued a small popular book (Fréchet and Halbwachs 1924).

The mood among the newly appointed professors was one of elation at their mission of creating a brand-new institution. The spirit of academic cooperation and interdisciplinarity was strong enough, especially in the humanities, for professors sometimes to pair in teaching their classes, to invite one another to their lectures and to convene regular Saturday morning meetings to discuss theoretical and practical issues about the curriculum (Craig and Burgos 1979).

The setting-up of novel institutes was not restricted to the Faculty of Sciences. For instance, the Faculty of Law created in 1922 an Institute of Comparative Law, with three sections, Germanic, Luxemburg, Slavic and Balkanic, aimed at foreign students. In history, Marc Bloch (1886–1944), who headed the Institute of Medieval History, and Lucien Febvre (1878–1956), his colleague the head of the Institute of Modern History, worked together and began the subsequently highly renowned *Annales d'histoire économique et sociale* at the beginning of 1929.

6.4 Strasbourg and Paris

Lest that it succumb to schematism, i.e., ideological blinkers, the historical narrative has to render reality in all of its somewhat confusing density. In this case, the field of predominant forces needs to be outlined.

As its new programs of study rolled off professorial desks, the University of Strasbourg had to advertise them profusely. This answered both the need to attract foreign students and the need, already mentioned, to assert itself as an institution of the first rank, not only rivalling but also improving upon its predecessor, the German Imperial University.

There was a catch, though. Gloating upon one's success brings attention to oneself. In France, for a provincial center to claim eminence of any kind is to throw a gauntlet to the capital city. Paris had encouraged Strasbourg to promptly regain excellence. But as soon as it did, it pounced. The very professors who had led this rebirth were lured to positions in Paris.

Paris exerted a powerful, well-nigh irresistible pull. What were the reasons for its attractiveness to an Alsatian academic in the 1920s?

There was prestige. In the French academic totem pole, the Sorbonne and the Collège de France ranked highest. Other Parisian institutions, the *Ecole normale supérieure* in particular—many of the professors in Strasbourg were its graduates—also ranked at the top. There would be increased international visibility.

There was money. A call to Paris translated into a greater salary, a 30 % increase.

There would be improved working conditions and increased funding. There would be easy access to publishers, concentrated as they were in Paris, predominantly in the Latin Quarter, close to the Sorbonne and the Collège de France.

Furthermore, Paris was also the seat of power, not only political. It housed the whole educational establishment: Parisian professors, appropriately nicknamed *mandarins*, controlled appointments of all kinds: membership of boards of examiners for competitive examinations such as the *agrégation*; professorships in all French universities; authorship of reports for various agencies of government, etc.

Not to mention the *Institut de France*. The supreme reward and distinction for a French academic was then, and to a large extent it remains to this day, election to one of the Academies, whether of the Sciences, of Moral and Political Sciences, of Inscriptions and Fine Letters – they all shared the same pre-requisite to becoming a full member. One had to be a Paris resident.

To complete this picture, the Alsatian professor moving to Paris during the 1920s need not worry about losing the quality of life he was familiar with. He would be greeted in Paris by the Alsatian diaspora there. By that time, this diaspora had permeated the highest French financial, educational and cultural spheres. The emigrating Alsatian would find the comfortable cocoon of a mini-Alsace in Paris, complete with *brasseries* serving Alsatian dishes, beers and wines.

By 1935, Paris had completed its first raid—there would be others—on the Strasbourg faculty. Many of the stars had left Strasbourg for Paris. Among the previously mentioned names, this was the case for Fréchet, appointed to a chair at the Sorbonne in 1928; Maurice Halbwachs, likewise in 1935; Marc Bloch, in 1928 already, entered his candidacy at the *Collège de France*; Lucien Febvre would enter the *Collège de France* in 1933; Louis Hackspill received a chair at the Sorbonne in 1932. As already mentioned, Henry Gault, as early as 1925, had left Strasbourg for a major responsibility in industrial applied research, as director of the Rhône-Poulenc R&D laboratories in Lyon.

No fewer than 20 professors from various disciplines were thus lured to Paris from Strasbourg between 1920 and 1940. Chemistry was not immune from losing its professors to Paris during that period. It did lose Henry Gault to the Sorbonne in 1933. It did lose Albert Kirrmann in the aftermath to World War II, when he was appointed assistant director at the *École normale supérieure.*

6.5 A Difficult Coexistence in Clermont-Ferrand

In the late 1930s, war seemed inevitable. As a border city, the French government foresaw the capture of Strasbourg by the Germans and prepared for that contingency. In particular, the University of Strasbourg, because it would be a major prize, was to be transported west. Clermont-Ferrand was chosen for the relocation (Dastugue et al. 1982; Chrétien 1984).

When war indeed broke out in 1939, the plan was followed. The entire University of Strasbourg, its equipment, faculty, staff and students, moved to Clermont (Sweets 1996; Strauss 2005a). Both universities, Strasbourg and Clermont, were to share the same buildings, although each was to retain its separate identity and administration. Accordingly, Alsatian chemists became housed in the chemistry institute headed by Professeur Léonce Bert. He proved to be a warm, congenial and welcoming host as they settled into their new, cramped quarters, during the fall and winter of 1939. Afterwards, there occurred a series of incidents, minor brushes at first, between the Alsatian chemists and Léonce Bert. It was fully chronicled. When I came upon these documents and was able to piece together the files from Strasbourg and from

Clermont-Ferrand, the whole unfolding story was crystallized. It greatly moved me. Others have already told of the unique feeling when suddenly uncovering from dusty archives the authentic voice of individuals from the past (Farge 2013). Thus, I followed the self-inflicted downfall of Léonce Bert. It was pathetic, a true tragedy.

Bert could not hide his spots, he was despotic, even petty at times. The first conflicts (see Boswell 1999) were trivial. The Alsatian scientists were dedicated research workers, 24/7. Bert would lock the gate to the *Institut de Chimie* at nights and on weekends. The Alsatians colleagues failed to respect the closed gate and opened it repeatedly.

He was a man of order; he wrote, and it makes for uneasy reading since the Vichy ideology shines through. He was training young people for work in industry; he wanted them to stick to regular hours and to be disciplined in every way. Unbeknownst to him, though, his immediate superior, the Dean, Professeur Emmanuel Dubois, had joined the Resistance. Dubois must have been rankled by Bert's ramblings in his frequent, sarcastic memos (those in particular of November 29, December 2 and 4 1940). Their antagonism, Bert a *pétainiste* and Dubois a *gaulliste*, reflected the division of the French in two camps and was the background for Bert's dismissal from all his university functions (Minutes, Faculty of Sciences, University of Clermont-Ferrand, October 31 1941).

6.6 Attack of the Nazis on the University of Strasbourg in Clermont-Ferrand

The German authorities were relentless in their twin goals of preventing the Strasbourg academics from pursuing their teaching programs and in plundering their laboratories from all their equipment, to be shipped to Germany after having been methodically inventoried. They were justified in doing so, in their view, by the age-old notion (*vae victis*) that the militarily victorious have every right, whereas the defeated have none. Their only restraint, it would seem, stemmed from the existence of the Vichy State. They paid lip service to it, knowing full well that, whatever the issue, they could impose their will on the French Administration.

Accordingly, the Strasbourg scientists in Clermont-Ferrand faced regular demands from the Nazis for their laboratory apparatus and for its transfer to Germany (Strauss 2005b). That they were frustrated in their plunder can be ascribed to one highly courageous person, André Danjon (1890–1967), the then Dean of the Faculty of Sciences (of the displaced Strasbourg University). He stood up to the Germans, alternating procrastination, postponing meetings at the last minute, recourse to the administrative line of command and carefully argued refusals. Many times, he could have been shot, deported at least for his attitude. He was finally fired from his deanship in 1942. His personal courage shines through reports of his numerous meetings in 1941 and 1942 with Kraft, the German representative. Their confrontations read like high drama. Danjon, an eminent astronomer in his own right, went on to become after the war director of the Paris Observatory (Rösch 1968).

The already mentioned Albert Kirrmann (1900–1974) was from a Protestant family. World War I worked to his benefit. After the war, he was admitted to the *École normale supérieure* in Paris without his having had to take the competitive entrance examination, as a special dispensation towards Alsatian students returning to the fold of French higher education. In 1935, when in the chemistry faculty in Bordeaux, he was called back to Strasbourg, in the chair just vacated by Henry Gault.

Kirrmann, a Calvinist, was an extremely kind person. He totally lacked aggression. He was extremely conscientious and worked hard at being impartial. He had a widespread reputation for fairness and personal integrity. The topics of his research in organic chemistry, prior to World War II, focussing on aldehydes and perfume chemistry, were very much in the tradition of the nineteenth century. On the eve of the war, Kirrmann started making use of Raman spectroscopy. He was moving thus in the direction of a more physically directed research.

When in 1940, the University of Strasbourg transferred to Clermont-Ferrand Kirrmann was included. In November 1943, Kirrmann was one of the professors arrested by the Gestapo, in a mass arrest of some 250 members, professors and students, of the University of Strasbourg in Clermont-Ferrand (Braun 1993). The reason for his arrest was, admittedly, his Jewish-sounding name. Albert Kirrmann did not protest the mistake; it would not have been in character for him to do so. He was deported to Buchenwald (Kirrmann 1996), where he somehow survived until liberation of the camp in April 1945 (Braun 1988).

Upon return to Strasbourg, it took a while for the research groups at the *Institut de chimie* to be able to resume work. The Germans had taken with them and hidden all the apparatus (in the universities of Tübingen and Freiburg). A French mission was able, with the help of the military in occupied Germany, to first locate and then retrieve the missing equipment (Defrance 2001).

In 1947 Kirrmann was elected Dean of the Faculty of Sciences. He discharged his duties with his usual hard work and total lack of malice to anyone. Needless to say, his laboratory took second place to his duties as an administrator. In 1954, Albert Kirrmann received a call from his alma mater, the *École normale supérieure*, in Paris (Brini 1980–2007; Charpentier-Morize 2005).

Charles Sadron was another professor in Strasbourg prior to World War II (Benoît 1980–2007). He also moved to Clermont-Ferrand. Like Kirrmann, he was arrested by the Germans in November 1943 and deported, to Dora in his case, the concentration camp that provided slave labor for the building of V2 rockets in the factory at Peenemunde led by Wernher von Braun. Sadron did his best to try and sabotage the rockets he was forced to help build.

Why were these two professors, Kirrmann and Sadron, deported? The Nazis were intent upon fatally weakening the University of Strasbourg. I presume that, even before the war started, they had made lists of scientists in Strasbourg who might contribute to the French war effort. Besides Kirrmann's presumed (but mistaken) Jewishness, his being a chemist meant that he might be useful to the French military in the production of chemical weapons. In Sadron's case, his expertise in aeronautics made him an obvious target; moreover, because of his Gaullist sympathies he got himself into trouble with Vichy France.

After he returned to Strasbourg, Sadron was intent upon setting-up an Institute of Macromolecular Science. Even before the war, Sadron had presented the Ministry of War with a project concerning plastics. His postdoctoral stay at Caltech, with Theodor von Karman as his supervisor, had introduced him to an American model for scientific research, which he termed “the research factory.” This continued to be his dream while he was toiling and trying to survive the horrendous conditions at Dora. Sadron’s dream institution would be based in Paris, gathering there the best French scientists in macromolecular science. Accordingly, he tried unsuccessfully to get himself appointed to either the Sorbonne or the *Collège de France*. He was barred by Georges Champetier, who taught polymer science at the Sorbonne. This man, a powerful *mandarin*, would not suffer competition in Paris and thus, Sadron was forced to remain in Strasbourg and to somehow fulfil his ambitions there. He convened an international conference on macromolecules in 1946, at a time when France was very much insulated from the outside, scientifically. Sadron then started *Centre de recherche des macromolécules* (CRM) in 1947; it was the very first Institute within the aegis of CNRS (*Institut propre du CNRS*). He was able to successfully petition the Parisian authorities for a new building to house CRM, which was granted to him in 1952 and formally opened in 1954 by Henri Longchambon, Secretary of State in charge of research and technology (Benoît 1989).

6.7 Survival of New Subdisciplines Started in Strasbourg

By and large, the 1920s offshoots from the University of Strasbourg thrived, whether they continued or not being part of the university. The *École nationale supérieure du pétrole et des combustibles liquides* moved into its new buildings in Strasbourg in 1925. In 1931, a rival school was set-up in Paris by Ingénieur général Paul Dumanois (1885–1964). During World War II, the Strasbourg institution survived by splintering off into sections in Toulouse and Paris. At the Liberation in 1944, *Institut français du pétrole* (IFP) was created and the Strasbourg institution was moved to the Parisian area, first into Saint-Maur and, in 1947, Rueil-Malmaison. Both schools were merged in 1946 and became a single *École nationale* in 1954 under the directorship of Dumanois. In 2005, Yves Chauvin (1930), a scientist working at the IFP, received a Nobel Prize in chemistry. He had pioneered mechanistic understanding of a chemical transformation, important to petrochemistry, the so-called olefin metathesis reaction. This award to Chauvin was a culmination for the IFP, justifying its investment in fundamental research.

The Chemistry Institute, on rue Goethe, which Paul-Thiébault Müller had turned into a school for training chemical engineers, has also survived. It remained in Strasbourg and as an autonomous part of the university. In 1948, it became *Ecole nationale supérieure de chimie de Strasbourg*. The CRM also survives and is vigorous within the University of Strasbourg. The *Institut de physique du globe* also continues its activities within the University of Strasbourg.

As for the *Annales* school of history, of course it left Strasbourg for Paris with professors Marc Bloch and Lucien Febvre. It still exists, through the periodical of the same name. It has had a strong worldwide influence on historical studies, with its zenith arguably during the period 1960–1980 (Burke 1991).

6.8 Overview and Conclusions

Upon its rebirth as a French university in 1919–1920, the University of Strasbourg faced two blind alleys. The French Government expressly forbade it from simply succeeding the German Imperial University. Such continuity would not wash. The other interdiction, which also came from Paris, concerned the dialectal Alsatian language; French was to be the only language of instruction. Thus, the new university was cut off from its linguistic and cultural roots in the Alsace.

To steer clear of a German influence, it cultivated its difference from a typical Central European university, such as in Budapest, Vienna or Warsaw. It patterned itself along something of a hybrid model, a cross between a typical French provincial university and an American-like institution.

The elements evocative of an American model were less formal teacher-student interaction than the traditional European way; a campus-like organization of the student body, with its very early internationalization, housed in dormitories somewhat resembling American fraternities; and professors in the sciences behaving as independent entrepreneurs, with an enthusiastic commitment to applied science, yet without neglect of pure science.

The mentality of some of the professors portrayed in this paper—Henry Gault or Charles Sadron, for instance—partook of both a French and an American model. Theirs was a pioneering spirit. Yet, competition between academics over a field of study was not encouraged, it was avoided. "Ownership" of a subdiscipline continued being the norm. The Strasbourg academics were encouraged to excel, not so much in an already existing field, with its established leaders and followers, but to venture into yet unexplored areas. Creation of new institutional offshoots was internalized by the newly appointed professors as a pressing moral, civic and patriotic duty. These offshoots were to be located in an intermediate zone, in a "no man's land" separating pure knowledge from technical know-how. Practicality was the touchstone of how best to be of service to the students and turn them into competent professionals (Olivier-Utard 2003).

One should be wary, though, of equating the University of Strasbourg during the 1920–1940 period chronicled here with a standard French university, which had been set towards the end of the nineteenth century as a conglomerate, the simple reunion of separate professional schools, Law, Medicine, Pharmacy, in addition to the faculties of Letters and of Sciences. What distinguished the University of Strasbourg were its professional schools representing subdisciplines rather than the whole: petroleum chemistry and physics, chemical engineering, macromolecular science, meteorology, statistics, for example. This produced a university 180 degrees from what the original brains trust, the Alsatian lobby in Paris before and during the Great War, had drafted and petitioned for.

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References

Allaud, Louis, and Martin Maurice. 1977. *Schlumberger: The history of a technique*. New York: Wiley.

Appell, Paul. 1923. *Souvenirs d'un Alsacien 1858–1922*. Paris: Payot.

Badariotti, Dominique, Richard Kleinschmager, and Léon Strauss. 1995. *Géopolitique de Strasbourg: Permanences, mutations et singularités de 1871 à nos jours. La Bibliothèque Alsacienne*. Strasbourg: La Nuée Bleue.

Benoît, Henri. 1980–2007. Charles Sadron. In *Nouveau dictionnaire de biographie alsacienne*, ed. Ch. Baechler, 3338–3339. Strasbourg: Fédération des sociétés d'histoire et d'archéologie d'Alsace.

Benoît, Henri. 1989. Les Macromolécules à Strasbourg. *Saisons d'Alsace* 106:113–120.

Boswell, Laird. 1999. Franco-alsatian conflict and the crisis of national sentiment during the phoney war. *Journal of Modern History* 71 (3): 552–584.

Braun, Lucien, ed. 1988. *1939–1943 Strasbourg—Clermont-Ferrand, Se Souvenir*. Strasbourg: Presses universitaires de Strasbourg.

Braun, Lucien. 1993. La Rafle de Clermont. *Saisons d'Alsace* 121:215–221.

Brini, Mathilde. 1980–2007. Albert Kirrmann. In *Nouveau dictionnaire de biographie alsacienne*, ed. Ch. Baechler, 3338–3339. Strasbourg: Fédération des sociétés d'histoire et d'archéologie d'Alsace.

Brophy, J. M. 2007. *Popular culture and the public sphere in the Rhineland, 1800–1850*. Cambridge: Cambridge University Press.

Burke, Peter. 1991. *The French historical revolution: The annales school 1929–1989*. Stanford: Stanford University Press.

Charpentier-Morize, Micheline. 2005. La Chimie organique conduite par Albert Kirrmann. In *La Science sous influence. L'université de Strasbourg enjeu des conflits Franco-Allemands 1872–1945*, eds. Elisabeth Crawford and Josiane Olff-Nathan, 223–227. Strasbourg: La Nuée Bleue.

Chrétien, André. 1984. L'Institut de Chimie de Strasbourg, sa création, ses 20 premières années, son exode à Clermont-Ferrand. *Chimie Strasbourg février*, 9–16.

Craig, J. E., and Martine Burgos. 1979. Maurice Halbwachs à Strasbourg. *Revue française de sociologie* 20 (1): 273–292.

Dastugue, P., M. Labadens, Pierre Laporte, Roger Vessière, P. Pochet, and Nicolas Wagner. 1982. Strasbourg et Clermont-Ferrand, une page de la vie universitaire en 1939–1945. *Revue d'Auvergne*, 435–448.

Defrance, Corine. 2001. La Mission du CNRS En Allemagne (1945–1950). Entre exploitation et contrôle du potentiel scientifique Allemand. *La revue pour l'histoire du CNRS* 5:54–65.

Dominian, Leon. 1915. Linguistic areas in Europe: Their boundaries and political significance. *Bulletin of the American Geographical Society* 47 (6): 401–439.

Farge, Arlette. 2013. *The allure of the archives*. (Translated by Thomas Scott-Railton). New Haven: Yale University Press.

Fauque, Danielle, and Georges Bram. 1994. Le "Réseau Alsacien". *Bulletin de la Société industrielle de Mulhouse* XX:17–20.

Finck, Adrien. 1980–2007. Charles Andler. In *Nouveau dictionnaire de biographie alsacienne*, ed. Ch. Baechler, 45. Strasbourg: Fédération des sociétés d'histoire et d'archéologie d'Alsace.

Finck, Adrien, and Maryse Stalber. 2004. *Histoire de la littérature européenne d'Alsace, XXème Siècle*. Strasbourg: Presses Universitaires de Strasbourg.

Fréchet, Maurice, and Maurice Halbwachs. 1924. *Le Calcul des probabilités à la portée de tous*. Paris: Dunod.

Friedel, Georges. 1926. *Leçons de cristallographie professées à la Faculté des sciences de Strasbourg*. Paris: Berger-Levrault.

Gautier, Armand. 1897. Paul Schützenberger. *Revue de Physique et de Chimie* XX:16.

Grendler, P. F. 2004. The universities of the renaissance and reformation. *Renaissance Quarterly* 57 (1): 1–42.

Juilliard, Etienne. 1965. L'Alsace, terre rhénane. Passé, présent et avenir. *L'information géographique* 29 (1): 1–8.

Kintz, Jean-Pierre. 1980–2007. Lucien Herr. In *Nouveau dictionnaire de biographie alsacienne*, ed. Ch. Baechler, 1542–1543. Strasbourg: Fédération des sociétés d'histoire et d'archéologie d'Alsace.

Kirrmann, Albert. 1996. Buchenwald la grande ville. In *Témoignages strasbourgeois: de l'université aux camps de concentration*, ed. Lucien Braun, 67–76. Strasbourg: Presses universitaires de Strasbourg.

Kisch, Herbert. 1989. *From domestic manufacture to industrial revolution. The case of the Rhineland textile districts*. New York: Oxford University Press.

Laszlo, Pierre. 2013. Albert Kahn (1860–1940): L'Alsacien De Paris, L'Américain de tempérament et le philanthrope. In *1870 De la guerre à la paix: Strasbourg-Belfort*, ed. Robert Belot, 279–292. Paris: Hermann.

Marsden, Walter. 1973. *The Rhineland*. New York: Hastings House.

Martin, Peter Laurence. 2012. *The European trade in stained glass, with special reference to the trade between the Rhineland and the United Kingdom 1794–1835*. York: University of York (Master thesis).

Moore, Rosalie. 1995. *Gutenberg in Strasbourg*. Cedarville: Floating Island Publications.

Nohlen, Klaus. 1997. *Construire une capitale. Strasbourg Impérial de 1870 à 1918.—Les bâtiments officiels de la Place*. Strasbourg: Librairie Istra.

Olivier-Utard, Françoise. 2003. La dynamique d'un double héritage. Les relations université-entreprise à Strasbourg. *Actes de la recherche en sciences sociales* 148:20–33.

Olivier-Utard, Françoise. 2010. L'université de Strasbourg de 1919 à 1939: s'ouvrir à l'international mais ignorer l'Allemagne. *Les Cahiers de Framespa*, no. 6: Universités, universitaires et relations internationales. http://framespa.revues.org/515. Accessed 30 Dec 2013.

Perdriat, Rémy. 1994. La chimie et la reconstitution de l'université de Strasbourg (1919–1925). Ruptures et continuités. *Bulletin de la société industrielle de Mulhouse* 833:107–115.

Rösch, Jean. 1968. *A la mémoire d'André Danjon [1890–1967]*. Paris: Société astronomique de France.

Russel, Jesse, and Ronald Cohn. 2013. *Ashkenazi Jews*. Miami: Book on Demand.

Smets, Josef. 1996. Économie paysanne et systèmes familiaux en Rhénanie aux XVIII^e^ et XIX^e^ siècles. *Revue historique* CCXCVI (599): 125–143.

Strauss, Léon. 1980–2007. Paul Appell. In *Nouveau dictionnaire de biographie alsacienne*, ed. C. Baechler. 58. Strasbourg: Fédération des sociétés d'histoire et d'archéologie d'Alsace.

Strauss, Léon. 2002. L'Alsace de 1918 à 1945: d'une libération à l'autre. In *La Presse en Alsace au XX^e siècle*, ed. Hildegard Chatellier and Monique Mombert, 39–52. Strasbourg: Presses universitaires de Strasbourg.

Strauss, Léon. 2005a. L'Université française de Strasbourg repliée à Clermont-Ferrand (1939–1945). In *Les Reichsuniversitäten de Strasbourg et de Poznan et les Résistances universitaires*, ed. Baechler Christian 237–261. Strasbourg: Presses universitaires de Strasbourg.

Strauss, Léon. 2005b. Chronique de la faculté des sciences de Strasbourg repliée à Clermont-Ferrand (1939–1945). In *La Science sous Influence. L'université de Strasbourg enjeu des conflits Franco-Allemands 1872–1945*, ed. Elisabeth Crawford and Josiane Olff-Nathan, 179–184. Strasbourg: La Nuée Bleue.

Sweets, J. F. 1996. *Clermont-Ferrand à l'heure allemande*. (Translated by René Guyonnet). Paris: Plon.

Thibodeau, K. F. 1976. Science and the reformation: The case of Strasbourg. *The Sixteenth Century Journal* 7 (1): 35–50.

Tilly, Richard. 1966. *Financial institutions and industrialization in the Rhineland, 1815–1870*. Madison: University of Wisconsin Press.

Viel, Claude. 1994. Le Professeur Henry Gault (1880–1967) fondateur de l'École du pétrole de Strasbourg et du Centre d'études et de recherches de chimie appliquée du CNRS. *Bulletin de la Société de chimie industrielle de Mulhouse* 1994:123–129.

Willemart, Antoine. 1949. Charles Friedel (1832–1899). *Journal of Chemical Education* 26:3–9.

Willems, Emilio. 1970. Peasantry and city: Cultural persistence and change in historical perspective, a European case. *American Anthropologist New Series* 72 (3): 528–544.

Pierre Laszlo a French physical organic chemist, worked on NMR and catalysis. Chairs and visiting appointments in Liège, the École polytechnique in Palaiseau, Hamburg, Lausanne seeded lectures in another two or three dozen European universities. Such internalization of their geography fed an interest into their history.

Chapter 7
Universities in Central Europe: Changing Perspectives in the Troubled Twentieth Century

Petr Svobodný

7.1 Introduction

All through the twentieth century, the fate of Central Europe was shaped by dramatic ideological, political, administrative, and legislative changes. Because of this, the developments in university education and science were always determined by changes in the relationship between the State and Academia. These changes occurred between a centre and its peripheries, and shifts in their hierarchy, among other matters.[1]

During the course of the twentieth century the Czech Lands (Bohemia, Moravia, and small part of Silesia) were a part of several political and state bodies with radically different political regimes: until 1918, they were provinces of the Cisleithan part of the constitutional Austro-Hungarian monarchy; from 1918–1938, they belonged (together with Slovakia and Subcarpathian Ruthenia) to a democratic Czechoslovak Republic, a state declaring itself to be a national state of 'Czechoslovaks', but in reality home to large ethnic minorities, largest of which was the German one; most of the Czech Lands territory became an 'autonomous' protectorate under the Nazi Third Reich (1939–1945, Protectorate Bohemia and Moravia); after World War II until 1989, they were again part of the independent Czechoslovak Republic, this time a state with a smaller territory (without Subcarpathian Ruthenia, annexed by the Soviet Union in 1945) and without a German minority (subjected

[1] This comparative study is based on secondary sources (published comprehensive histories or specialised studies concerning particular institutions). Wherever possible and such literature on Czech issues exists, sources are quoted in English, eventually German. References to Czech sources are kept to a minimum. The theoretical concept of space, of relations between centre and periphery, and the notion of hierarchy have recently been used by Jan Jakub Surman in his dissertation to study universities of the Habsburg Monarchy. (Surman 2012, especially Chap. I, Imperial Geography of Knowledge—Introduction:15–55).

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to the so-called transfer in 1945/46); from 1948, this Czechoslovakia became Communist, a state within the sphere of the Soviet Union and until 1968, it was a unitary state, after that, a federative one (still the official name of the state was the Czechoslovak Socialist Republic, since 1960); following the fall of Berlin Wall in 1989 and the decline in Communism, the Czech Lands briefly remained part of a gradually dissolving federation, the Czech and Slovak Federal Republic. Since 1993, an independent Czech Republic has prevailed, which since 1999 has been a member of NATO and from 2004 a full member state of the European Union (Agnew 2004; Pánek and Tůma 2009).

In Central Europe, changes that occurred in higher education in connection with political upheavals usually had an impact both on the structure of the university network (numbers, types, and location of universities) and on academic policies (science and university policy, curriculum, administration and financing of universities and research institutions). A specific feature of twentieth century developments in Central Europe is that the alterations in state organisation that occurred in 1918, 1938/39, 1945–48, and in 1989 resulted not only in 'simple' administrative reforms but also brought about a degree of ideological pressure (explosive nationalism of the nineteenth and early twentieth century, Nazism, Communism). Alongside with fundamental changes in administration and conception that were carried out under the banner of the ruling ideology (in the name of the nation, race, working class, democracy, Europe), transformations of structure and content of academic education were also frequently motivated by 'objective' reasons (development of scientific disciplines, demand for experts with academic education), which were not part of the 'central' policy. Even here, however, it is often hard to draw a clear line between the internal developments within scientific disciplines or institutions and politically or ideologically motivated interference in their structure and direction.

In the past several years, the transformations that Central European academic institutions experienced in connection with the most important political events of the twentieth century have become the subject of several international conferences and research projects. The disintegration of the system of higher education, science, and research of the defunct Habsburg monarchy and the subsequent construction of corresponding systems within the newly established national states (especially the Republic of Austria, Czechoslovak Republic, and Yugoslavia) became the focal point of two conferences on *Science and Technology in Successor States of the Habsburg Monarchy, 1918–1938: Transformations, Networks, Mobility*, which were organised in Vienna in 2009 and 2011.

Of crucial importance for the Czech Lands and Austria and their universities and other academic institutions were the fateful events that unfolded in the 1930s and 1940s in neighbouring Germany. Years 1933 and 1945, which constituted a turning point (*Umbruchsjahren*) in the sense of an overturn of a political system (*Systembruch*), influenced the relation between science and academic education on the one hand and politics and ideology on the other hand not only in Germany but also shortly later (after the 1938 *Anschluss*) in Austria and in the Czech Lands (gradual annexation in 1938 and 1939). Various continuities and discontinuities in academic policies, organisation, and daily running of schools that occurred after the Nazi rise to power in Germany (1933), in Austria (1938), and after the occupation also in the

Czech Lands (1939), but also those that transpired after the defeat of Nazi Germany and during the subsequent de-Nazification (1945), were treated, for example, in contributions to a 2006 international conference of university historians in Berlin, which aimed to follow these subjects in a comparative international perspective. (Schleiermacher and Schagen 2009).

An even broader regional and chronological approach was adopted by another comparative project, which dealt with the radical changes in academic education in twentieth century Central and Central–Eastern Europe. It focused on issues of university autonomy before the arrival of the totalitarian regimes, under the pressure exerted by those regimes (i.e., Nazis in 1933–1945, Communist in 1948–1989), and attempts at restoration of university autonomy after the defeat of Nazism in 1945 and the fall of Communism in 1989 (Pešek et al. 2009). Comparisons followed not only the chronological axis—the long and complicated way towards autonomy of German universities after the fall of Nazism and extinction of the German Democratic Republic (Pešek 2009)—but focused also on various regions (Germany, Austria, Czechoslovakia, Poland, and Ukraine) and analogies or differences in their post-1945 and post-1989 development (esp. in Germany and Czechoslovakia).

With changes in the position (subordinate, equal, or dominant) of the Czech Lands within the state organisation and international status of Central Europe over time and space, there also evolved the importance and the role of Prague as their administrative, economic, cultural, and also naturally their academic centre.

In the Middle Ages and early modern period, Prague was the capital city of the Bohemian kings and sometimes a seat of Roman emperors and kings (Charles IV in the fourteenth century, Rudolf II in the sixteenth/seventeenth century, among others). In the early modern Habsburg monarchy, it became merely one of its many provincial capitals (as for example Brno in Moravia, Budapest in Hungary, Graz, Innsbruck etc. in the Austrian Lands), that is, cities peripheral with respect to imperial Vienna. In the second half of the nineteenth century, however, Prague grew in importance as the informal capital of ethnic Czechs and a symbol of Czech statehood. Between the world wars and after WWII, Prague was the capital city of an independent state (Czechoslovakia). Changes in the territory and structure of whichever state entity Prague and other university towns belonged to (administratively and in prestige), influenced its position in the hierarchy of other central European cities. These changes also affected the hierarchy and relations between various universities.

Focusing on universities in the present-day Czech Republic (and analogously in Slovakia, with some remarks on Poland, Hungary or post-Yugoslav republics), I want to study namely two main tendencies:

1. Upward processes: transformation of the Czech university in Prague from an Austrian provincial school before 1918 to the leading nation-wide institution in Czechoslovakia and its role in founding and building of "daughter" institutions in provinces (Brno, Bratislava) after 1918 and 1945. Some of the new peripheral institutions under changed circumstances again became central: this was repeatedly the case of Bratislava in Slovakia (1939, 1993), and analogously the case of universities in Zagreb (Croatia) or Ljubljana (Slovenia) after 1990.

2. Downward processes: regionalisation of university education and reserch, i.e., founding and building of new institutions in the provinces (Austria before 1918; interwar Czechoslovakia; post-1945 Czechoslovakia; the Czech Republic after 1990).

Special attention will be paid to the specific story of the German University in Prague and its metamorphoses from a provincial Austrian school (1883–1918), to a school of the German minority in interwar Czechoslovakia, to a *Reichsuniversität* (1939–1945).

Shifting perceptions of the scale/perspective/focus (regional/provincial x national x international or peripheral x central) can be found as well in the concept of the role of universities in the public sphere (for example public health facilities linked with medical faculties).

7.2 Provincial Universities in the Multinational Habsburg Empire before 1918

A university has existed in Prague since the middle of the fourteenth century (established in 1348), making it one of the oldest in the world. In the second half of the nineteenth century it was an important centre of education and research in many fields, including medicine, physics, and chemistry, among others. However, Prague University was, like many others, a second-rank institution, although not in qualitative aspects. Its sphere of competence, though, was limited to a particular administrative unit, the province of Bohemia (Čornejová and Svatos 2001; Havránek and Pousta 2001).

The culmination of emancipation efforts of the small central European nations at the end of the nineteenth century brought significant changes in the position of some, hitherto provincial, universities. National languages (Czech, Polish, Hungarian, Croatian) started spreading to the academic ground alongside German, and the thus-changed academic institutions quickly became important centres of various central European nations, even if still within the political framework of the Habsburg monarchy (Binder 2003a).

Prague University was divided in 1882 into two fully independent institutions, a Czech and a German one. This led to significant changes in the functioning and perception of both. The German one remained a provincial German-speaking 'Austrian' institution, like other universities subject to the Ministry of Culture and Education in Vienna. After 1882 and even after 1918, the German University in Prague remained an integral part of the network of linguistically German universities of Central Europe but it became rather a starting or transfer point within this system. The symbolical hierarchy of German-speaking universities in Austria was aptly expressed by a well-known saying connected with the appointment of new professors: "*Sentenced to Chernivtsi, pardoned to Graz, promoted to Vienna*." (Surman 2012, p. 252). On this Austrian 'university chart', the German University in Prague corresponded roughly to the level of Graz. To the Germans from the Czech

Lands, Prague usually served only as a starting point, a transfer station before arriving at the most desirable university of Vienna. It fulfilled this function not only with respect to locals and candidates from other provinces of the Habsburg monarchy, but also with respect to graduates of universities of the German Reich (Svobodný 2011).

The Czech university in Prague was also—like the German one—part of the network of Cisleithan academic institutions but, since it was Czech-speaking, it became the main academic institution of the Czech nation (Seibt 1984; Lemberg 2003). In 1882–1918, the academic environment in Prague was largely determined by the parallel existence and competition between two linguistically distinct universities, the Czech and the German one (and analogically also by the rivalry between the two technical universities). This competition manifested itself not only on a practical level, such as the establishment of institutes of the Czech university and the promotion of its status not only within the linguistically Czech science, but also in international competition on the one side, and a struggle for the provision of adequate material, financial, and staffing support by the Austrian authorities on the other side; also on a symbolic level. A visible reflection of the two Prague universities' competition for prestige, which was part of a broader political struggle of the Czechs within the Austrian monarchy, is found in the newly built or planned representative buildings of the universities (Marek 2001). The long and winding story of the mutual relations of the Prague universities, i.e., the Czech and the German one, and the changes it has undergone depending on regime changes in 1918, 1938/1939, and 1945, are, as will be shown below, in many ways reminiscent of the alternating, and unlike in Prague, not co-existent, German and French universities in Alsace (Strasbourg) after 1871, 1919, 1940, and 1945 (Wirbelauer and Schappacher 2010).

The transformation of the Czech university in Prague from a peripheral into a central academic institution was spearheaded by the efforts of its professors to establish a second Czech university in Moravia (Fasora and Hanuš 2009). There ensued a fast re-orientation of its international relations from the hitherto-dominant role of Austrian or German academic institutions to schools in Western Europe and Slavic countries. As to its function and prestige, the Czech university in Prague occupied a position somewhere between the most important university in the imperial capital, and the 'merely' provincial schools of Graz and Innsbruck. Over time, other universities within the Austro-Hungarian Empire found themselves in a similar situation of a formerly provincial school that is at the same time the top national academic institution. This was the case of the Hungarian university in Budapest, the Polish universities Lwów (Lemberg) and Kraków (Cracow) in Galicia, and finally also the Croatian university in Zagreb. National languages (Hungarian, Polish, and Croatian) were introduced or re-introduced as languages of teaching and research during the 1860s (Stopka 2000; Binder 2003b; Mészáros 2003; Surman 2012, pp. 56–90). More universities and academies with Hungarian as the language of instruction were established at the turn of the nineteenth and twentieth centuries, including the Elizabethan University in Pozsony (Pressburg, today Bratislava in Slovakia).[2]

[2] The Hungarian Elizabethan University in Pozsony/Bratislava was founded in 1912. After foundation of the Czechoslovak university in Bratislava in 1919, the Hungarian university was transferred from Bratislava to Pécs (Hungary) in 1923.

7.3 Completion, Restructuring, and Modernisation of the Higher-Education Network in Interwar Czechoslovakia (1918–1938)

The first Czechoslovak Republic (1918–1938) inherited from the defunct Austro-Hungarian monarchy not only an existing network of universities in the Czech Lands (not in Slovakia) but also a model of academic education in general. The same holds of the laws regulating the functioning of universities and colleges, which was based on mid-nineteenth century reforms connected with the name of Count Leo Thun-Hohenstein. The so-called 'reception norm' (Act No. 11/1918 Coll.) meant the adoption of the entire hitherto-existing Austrian and Hungarian legal system, including academic education. In 1927 the university legislation of the Czech Lands was implemented in Slovakia. This legislation remained in force, save for minor adjustments and with the exception of the period of 1939–1945, until the arrival of the Communist party university reforms of the late 1940s and early 1950s. One of the main tasks of the new Czechoslovak state after 1918 was a completion, restructuring, and modernisation of the system of higher education.

In 1918, there were nine universities and academies in the Czech Lands: two full universities in Prague (the Czech and German); two technical universities in Prague (a German one since 1815, and a Czech one since 1869: Tayerlová 2002); two technical universities in Brno (a German one since 1873, and a Czech one since 1899); the Academy of Mining in Příbram (German, since 1865); the Academy of Visual Arts in Prague; and an independent Catholic Faculty of Theology in Olomouc (remnant of a former university) (Ebel 1928). In the territory of Slovakia, there existed the Hungarian Elizabethan University, the only partially functioning part of which was a medical school, and five so-called 'academies' with Hungarian as a language of instruction (law academies in Košice and Prešov; Protestant theological academy in Prešov; academy of economics in Košice; and an academy for mining and forestry in Banská Štiavnica). There was no institute of higher learning with Slovak as the language of instruction. Some important universities often attended by students from the Czech Lands remained outside the borders of the new state (veterinary, military schools) (Ebel 1928).

Completion, restructuring, and modernisation of the network of higher education included mainly an adjustment of the number, equipment, facilities, and financing of the Czech and German institutes of higher education (especially universities) so that it would correspond to the proportional numbers of Czech and German speakers and the new political situation. As well, there was an establishment of a Slovak system of higher learning that would include both universities and technical schools and a completion of a system of higher learning in terms of areas covered, be it a matter of replacement for institutions that were outside the new borders (veterinary, military schools) or institutions whose foundation was required by increasing modernization and specializations (economics, natural sciences, etc.). There was a more even distribution of institutions of higher learning over the territory of the new state (Bohemia, Moravia, Slovakia) and a foundation and development of a non-university sector of research. In addition to these basic trends, the restructuring of the system of higher learning and research was also subject to various national, partisan, prestigious or symbolical pressures on the one hand, and to financial and organisational limitations on the other. In practice, the above-mentioned trends frequently coincided, as exemplified by Brno, where all applied at the same time.

Shifts in state policy priorities in relation to the Czech, Slovak, and German systems of university education in interwar Czechoslovakia as well as the demands and ambitions of universities with respect to the state were a sign of completion of a process of national emancipation, which was accompanied in Central Europe since the mid-nineteenth century by the establishment of systems of university education that were autonomous and 'national' in the ethnic sense of the term.

With the foundation of the Czechoslovak Republic in 1918, the Czech university in Prague became the 'first and foremost' institution of its kind in the new state: it had the longest tradition, largest size, greatest prestige, and served as a model for the founding of other Czechoslovak universities. Its privileges were expressed, among others, by a law of 1920, which acknowledged it as the sole rightful successor to the original foundation of Charles IV of 1348, and named it 'Charles University'. This right to succession was, on the other hand, denied to the German University in Prague (Havránek and Pousta 2001, pp. 180–201). The German University in Prague became an academic institution of a national minority in the 'national state of Czechoslovaks' but even during the interwar period, it did not lose its scientific contacts with other German-speaking universities abroad (Havránek and Pousta 2001, pp. 245–256).

The teachers of the Czech Charles University played an important role in 1919 in the foundation of new Czechoslovak universities: the long-planned second Czech university in Brno (Moravia), and the first Slovak university in Bratislava (Borůvka 1969). The university in Bratislava had since its foundation a special status. Formerly (as expressed, for example, by the formulation of the act establishing the university), it was a Czechoslovak institution but its faculty and academic officials (including the first Rector) were almost exclusively Czechs who brought to Bratislava (as well as to Brno) Prague experiences and knowhow—a transfer of knowledge. The mission of this university was, however, focused on educating Slovak experts and intellectuals, so that already in the second generation, the proportion of locally educated Slovaks significantly grew. A full Slovakisation of the university, however, occurred only later, under changed political circumstances, immediately after the proclamation of Slovak autonomy in November 1938, in practice, by the expulsion of all remaining Czechs (Bartl and Varsik 1969; Beniak and Tichý 1992).

Alongside the 'parent' Charles University in Prague, interwar Czechoslovakia thus had two more successfully functioning 'daughter' universities active in provinces (Moravia and Slovakia). The university in Bratislava also aspired to being the first Slovak academic institution of its kind not only in the regional sense but above all in the context of national emancipation and modernisation. It was gradually rising to a position analogous to that of the Czech university in Prague within the Cisleithan universities before 1918. Originally, many academics from Bohemia went to Bratislava and to Brno prompted by a degree of pioneering zeal and by hopes of career advancement, which would come faster than at the long-established university in Prague. Soon, however, in many of them a return to an approach similar to the previous era could be detected, which may be summed up by the epithet 'Sentenced to Bratislava, pardoned to Brno, promoted to Prague'. This is borne out primarily by numerous published as well as unpublished memoirs and correspondence.

Besides the two new universities, other important institutions of higher education were established shortly after the declaration of an independent Czechoslovakia, i.e., in 1919 and 1920. Universities of veterinary medicine and agriculture in Brno were founded to replace lost institutions in Vienna and the foundation of new faculties of natural sciences at the existing universities or new specialized schools in the framework of technical universities was a result of specialization and modernization of university education and research. From the viewpoint of the structure of higher education, the fast accomplishment of the process was doubtless successful, especially as far as the Czech (or Czechoslovak) institutions were concerned. The German system of higher education was not restricted, but Hungarian academic institutions in Slovakia disappeared altogether. While a more-or-less even representation of all of the requisite types of institutes of higher learning and research existed within the state as a whole, within Slovakia, the system of higher education was not completed until late 1930s. From a territorial point of view, the location of various types of institutions of higher education was quite even in Bohemia and Moravia, but less so in Slovakia. The main centre of higher education was traditionally Prague but newly also the Moravian Brno. Ruthenia with its rural economy had no universities during the entire interwar period.

Higher education in the Czechoslovak Republic was, for good or bad, markedly national in its character. Czechs, Germans, and Slovaks had each their own schools. The establishment and later also the financing of institutes of Czech (Czechoslovak) higher education was repeatedly the target of criticism both from the German and Slovak but later also the Czech nationalist circles. Similarly, the official university policies and even the everyday running of academic institutions was often the subject of partisan conflicts and public discussions. Collaboration between the Czech and the German schools, both the institutions and individuals, in the Czech Lands was already limited prior to 1918. Similarly, before 1918 Czech academics had already started re-orienting themselves from Austrian and German schools to other institutions in Western Europe and, after 1918, especially to the USA.

The short and powerful wave of creation of new institutions, which, although highly visible, was but one part of the new and ambitious policy of higher education, soon lost momentum due to overstretched financial demands. That is why the implementation of some projects was delayed, was partial, or did not happen at all.[3]

[3] This chapter on the interwar period is based on my paper presented at the symposium Science and Technology in Successors States of the Habsburg Monarchy, 1918–1938: Transformations, Networks, Mobility, held in Vienna in November 2011. Proceedings of the symposium will be published.

7.4 Disintegration and Devolution of Original Czechoslovak System (1939–1945)

The year 1939 brought a radical disruption both in the Czech and Slovak history. In the last few years, several conferences and substantial projects with impressive publication outputs have dealt with the fate of the former Czechoslovak universities and non-academic scientific institutions in the 1939–1945 Second World War period (Glettler and Míšková 2001; Kostlán 2004). Changes in higher education in Bohemia, Moravia, and Slovakia during this time have already been summarised and clearly described (Konrád 2011). The main features shared by the changes that occurred at universities and scientific institutions of the already defunct Czechoslovakia after 1939 were a fast disintegration of the original Czechoslovak system and its devolution into three fully separate structures.

After the proclamation of Slovak autonomy within the post-Munich second Czecho-Slovak Republic in November 1938 and later, with the creation of an independent Slovak Republic in March 1939, Slovak universities became part of a national system of education, administered by its own Slovak ministry. German universities in the territory of Bohemia and Moravia were, after the March 1939 occupation of the Czech Lands and creation of the Protectorate, removed from the system, which was henceforth administered by the Czech Ministry of education, with competence only for the Protectorate of Bohemia and Moravia, and fully integrated into the education system of the Third Reich. In March 1939, however, linguistically, Czech universities had only six months of existence ahead of them: the latter were closed in November 1939 and remained so until the end of occupation, i.e., until May 1945.

In the breakaway territory of the independent Slovak Republic, the university in Bratislava—now the capital city of an independent state—became the top academic institution of the land and nation. The existing university, renamed Slovak University to replace the former name Comenius University, profited from this state of affairs, e.g., by completing some of its faculties, namely the Faculty of Natural Sciences in 1940. One of the very clear signs of a radical departure from a position of subordination to Czech administration and academic models was the above-mentioned Slovakisation of the teaching staff. The other important feature of Slovakisation of universities after 1939 was their subjection to the authoritative policies of the new regime, which was in some ways similar to the Nazification of universities in Germany and included, among other things, the removal of Jewish teachers and students (Konrád 2011, pp. 88–91).

The German University in Prague also significantly changed its status and sphere of competence during the period of occupation of Bohemia and Moravia. After the 'unavoidable' Nazification of the teaching staff, which had occurred during 1938/39, and the expulsion of Jewish students, the German Charles University in Prague (the new official name since 1939) was, in the summer of 1939, formally and practically fully integrated into the academic system of the Third Reich. It thus became more firmly than ever part of a network of German universities reaching from Strasbourg to Königsberg and from Kiel to Graz.

New or substantially modified disciplines appeared both on the list of courses and in the research projects. These changes were most acutely felt in those disciplines that were deformed by Nazi ideology (especially racial hygiene; biology; anthropology; German and Slavic studies, among others) or by preparations for war (military medicine, chemistry, physics, among others) (Svobodný 2004; Šimůnek and Schulze 2008; Konrád 2009). The period of the WWII years, especially its beginning, was, according to most German academics, possibly the best in the school's history, mainly with respect to opportunities for scientific work, even though in other respects the German Charles University in Prague was, by comparison to other German universities, rather second-rate. This favorable situation changed dramatically with the progress of the total mobilization of forces for the war effort. Recruiting affected not just the teachers but also the main student body. On the other hand, the German university in Prague was spared the fate of many of its counterparts in bombed-out German cities until the very last weeks of the war. The last graduations (at the Faculty of Medicine) took place as late as the beginning of May 1945 but by that time many of its academics were already leaving Prague fearing both the advancing Soviet Army and an expected retaliation from the Czechs (Wróblewska 2000; Havránek and Pousta 2001, pp. 257–262; Míšková 2007; Konrád 2011).

All the Czech universities were closed by the Nazi authorities in November 1939. The anti-German demonstrations in October and November 1939 had served as the pretext for this closure but in fact, their liquidation was part of a planned campaign against the Czech intellectual, professional, and political elites; a process similar to that in occupied Poland (Gaweda 1981; Buszko and Paczynska 1984). Of the actions undertaken against Czech universities on November 17, 1939, nine student leaders were immediately executed and almost 1,200 students sent to the concentration camp in Sachsenhausen. All Czech students lost the chance to complete their studies for the next five years (Pasák 1997; Havránek and Pousta 2001, pp. 199–201). The lives of the teachers of the closed universities took various turns. Most tragic was the fate of those who became victims of racial persecution and those who participated in the resistance movement and were captured (Glettler and Míšková 2001).

However, thanks to their clinical background, medical faculties in Prague and Brno in the provincial hospitals retained at least a small part of their original functions. Some members of the teaching staff not only continued their work in hospitals but even received official permission to carry on scientific work. In practice, though, this activity was often curtailed. Similarly, a limited continuation of scientific work was permitted in practically oriented institutions of some other universities, especially the agricultural and the veterinary school in Brno and the mining academy in Příbram. From a broader European viewpoint, one should mention the opportunity given to several dozen Czech and Slovak medical students in British exile. Based on an agreement between the Czechoslovak government-in-exile and the British authorities, these doctors could complete their studies at various British medical schools and graduate at Oxford University, formerly under the auspices of the closed universities in Prague and in Brno (Svobodný 2009).

7.5 Reconstruction, Regionalization, and Sovietization (1945–1989)

The restoration of an independent unitary Czechoslovakia in 1945 led to the reconstruction of the original structure of Czech and Slovak universities, where the universities in Prague, Brno, and Bratislava played a key role. An important change came, however, with the disappearance of the German academic system, the institutions of which, including the German University in Prague, were closed in connection with the expulsion of the German population (Míšková 2007, p. 237). Many members of the former German University in Prague started new academic careers at universities in Germany or Austria after 1945 (Svobodný 2005; Míšková 2007, pp. 238–246).

In the period of 1948–1989, as noted, universities in Czechoslovakia largely conformed to the Soviet model of higher education (Connelly 2000). In addition to various basic internal changes thereby necessitated, this model was characterised by a large representation of the non-university sector of education, research, and science. During this period, only two complete universities *sensu stricto* were founded in Czechoslovakia, both of them not long after the end of World War II: one in Olomouc in Moravia (1946), the other in Košice in Slovakia (1959). Other new institutes of higher education, founded mostly before the mid-1950s, were mainly highly specialised institutions intended to serve the needs of a country in the process of 'building socialism' (e.g., technical, agricultural, economical, and pedagogical schools). For the most part, they were established not in the traditional university centres but rather in regional towns of Bohemia, Moravia, and Slovakia. The main reason of this Europe-wide trend (Rüegg 2011, pp. 31–69) was the need to accommodate the increased numbers of students that flooded into schools after the war (the post-war 'Baby Boom'), and to provide better geographical access to higher education. Another consideration behind this trend was the interests of the regions therein concerned, including various specific cultural and historical demands (as in Olomouc) or financial, economic, and social needs (e.g., in Košice or the industrial town of Ostrava) (Urbášek and Pulec 2012). At the same time, the importance and prestige of traditional universities suffered considerably with the transfer of a large part of research and scientific activities into various institutes of the newly established Czechoslovak Academy of Sciences (in 1952) (Míšková et al. 2010). The 'original' Charles University in Prague, however, was still in reality considered to be most prestigious (Havránek and Pousta 2001, pp. 265–301). In Slovakia, this position was occupied by the Comenius/Slovak University in Bratislava; its prestige derived both from being the oldest 'national' university and from its position as a 'parent' of new schools or their branches (Košice, Martin). This leading position was formally reinforced after the federalisation of Czechoslovakia in 1968, which brought Slovak universities under the jurisdiction of a new ministry of education in Bratislava.

During the interwar period, Czechoslovakia harboured many students and scientists fleeing their countries of origin for political reasons: escaping the *numerus* *clausus*, which applied to Jewish students in a number of East European countries, running from the Soviet Union in the 1930s, and somewhat later, leaving the Nazi Germany[4] (Kostlán and Velková 2004). On the other hand, in 1948–1989, scientists, teachers, and students were led by political reasons to escape from Communist Czechoslovakia (Štrbáňová and Kostlán 2011).

7.6 Transformations and Reforms (1990-)

After 1990 and after the break-up of the Czechoslovak federation, the Czech Republic (and analogically also the Slovak Republic) witnessed a strong increase in the establishment of institutes of higher education. Almost every regional administrative centre in the Czech Republic (13 altogether) saw the foundation of a new, more or less complete, university *sensu stricto*. For the most part, they were created on the basis of already existing institutions (usually pedagogical or technical schools). Another strong trend in the Czech Republic post-1992 has been the growth of a structure for the non-state higher-education sector and the establishment of private 'universities' that focus mainly on management or social sciences. 'Classical' universities and several other specialised university establishments (24 institutions specialising in economy, technical sciences, veterinary medicine, agriculture, or arts) nowadays form a 'public' sector, which is in fact state-run, although in name the only 'state universities' are the Police Academy and Military Academy. The number of non-state (private) institutes of higher learning that hold a state accreditation stands currently at approximately forty. A large part of research and scientific activities remained even after 1990 not only within the university framework but also in the institutes of the Academy of Sciences of the Czech Republic.

In the aftermath of the 1989 'Velvet Revolution', the system of administration and financing of academic education and non-academic scientific institutions both as a whole and within individual institutions also experienced fast and, to varying degrees, radical changes. The beginning of this process was characterised by a return to academic autonomy, with new laws on universities in 1990, 1998 (Pousta 2009; Malý 2009), and continued with the accession of the Czech Republic to the so-called Bologna Process. All of the abovementioned changes and trends were naturally subject to lively debates both in the academic sphere and in the broader political circles and public sphere, which continue. The situation is similar in neighbouring Germany, where various transformations of universities of the former GDR since 1990 interact with debates on university reform that occur within the entire state (and within Europe) (Grüttner 2010, pp. 303–377).

These and other features of the development of the system of higher education in the Czech Republic are highly similar to the situation in the Slovak Republic.

[4] During this period, there existed in Prague universities for Russian and Ukrainian emigrants. Political refugees from Germany found a temporary safe harbour at German universities in Czechoslovakia until these, too, were Nazified or self-Nazified.

The Comenius/Slovak University of Bratislava finally became a central national institution in Slovakia with the break-up of the Czechoslovak federation and the foundation of an independent Slovak Republic in 1993.

Conclusions

The ways in which the Czech Lands (present-day Czech Republic) were incorporated in various changing state entities (supra-national empire, multinational state, federation, national states, international integrations) in the course of the 20th century significantly influenced the structure and hierarchy of academic institutions. Similar processes took place all over Central and Eastern Europe. One could follow similar structural change in an even more pronounced form in the case of Polish universities, especially in connection with the 'shifting' of Polish territory between the three empires before 1918, interwar Poland, between the Nazi Germany and the Soviet Union in 1939–1945, Communist satellite and then once again independent Poland during 1945 to early 1990s (Vykoukal 2009; Zilynskyj 2009). A 'promotion' of provincial institutions to main national institutions in the context of transformation of multinational states through federations to independent national states could also be followed with interest in the former Yugoslavia or the former Soviet Union after 1990.[5]

The structure of higher education, principles of its administration and financing, curricula, science policy, and the like have always been strongly influenced by political and ideological interference. In consequence of the frequent changes of political regimes in twentieth century Central Europe, these intrusions were often devastating. This was a result of not only the nature of these regimes and their ideologies (Nazism, Communism) but also of the very frequency of the changes.

Though fast political changes and systemic transformations that followed in their wake had a significant impact on the system of universities and non-academic scientific institutions, a perspective that takes into account a longer period (end of the nineteenth until early twenty-first century) shows some longer-term developmental tendencies and elements of continuity. Such a broad perspective was recently chosen, for example, by German colleagues in their study of the development, transformations, and changes of 'scientific cultures' (*Wissenschaftskulturen*) in the politically turbulent twentieth century. Similarly, as in the German case, where the study transcended the traditional division according to system disruptions (*Systembrüche*: 1918, 1933, 1945, 1990) and focused on long-term changes, processes, and trends going beyond thus strictly defined periods of university history (Grüttner 2010, pp. 15–16), one can also detect uninterrupted continuity in the Czech case.

[5] The University of Tartu (Estonia) offers a fascinating and extreme example of changes experienced by a university based on its position in the system of higher education in a given state—and the oscillation between a peripheral and central status connected with it—on the one hand and the vicissitudes of changing political regimes on the other hand (Hiio and Piirimäe 2007).

Regarding our topic—processes of ascent; transformation of regional universities into national institutions versus processes of descent; a new phase of regionalisation and provincialisation of higher education—one can trace two main elements of continuity.

The first is a general model of Central European higher education, which is declaredly aligned with Humboldt's notion of unity of teaching and science. In practice, this Humboldt model was applied in the Austrian monarchy during reforms driven in 1848−1869 by Count Leo Thun-Hohenstein. This 'Austrian' model was then in varying degrees preserved in successor states, most comprehensively, with the exception of Austria proper, in inter-war Czechoslovakia. After its replacement in 1950−1990 by a Soviet model, universities in the Czech Republic after 1993 again declared inspiration from Humboldt's conception. However, at the beginning of the twenty first century, this principle is, in its present-day form of scientific excellence, in practice barely compatible with the opposite trend of mass higher education. What is thus observed is an increasing divergence between the by-now traditional universities founded before the mid-twentieth century and the regional or private universities established after 1990.

The other element is a continuity of reform plans, attempts, or discussions on the one hand and their implementation on the other. This is observed, for example, again in the context of establishment of new regional universities in the Czech Lands. Given the high frequency of changes of political regimes, it is often the case that one or more generations of persons participated in the—often opposing—transformations during one or more periods of political change. The 1945−1950 foundation of new regional universities was in some cases a culmination of efforts from 1918−1920 just as the wave of regionalisation of higher education after 1990 amounted in many cases to an implementation of plans from 1945−1950. This happened regardless of the difference in the nature of the regimes under which these processes took place and regardless of the reasons, real or declared, which inspired the establishment of those new institutions.

References

Agnew, Hugh. 2004. *The Czechs and the Lands of the Bohemian Crown*. Stanford: Hoover Institution Press.

Bartl, Július, and Branislav Varsik, eds. 1969. *50 rokov Univerzity Komenského v Bratislave* [50 years of the Comenius University in Bratislava]. Bratislava: Comenius University Press.

Beniak, Milan, and Miloslav Tichý. 1992. *Dejiny lekárskej fakulty Univerzity Komenského v Bratislave* [History of the faculty of medicine of the Comenius University in Bratislava]. Bratislava: Comenius University Press.

Binder, Harald, ed. 2003a. *Position of national languages in education, educational system and science of the Habsburg Monarchy 1867–1918*. Praha: Research Center for the History of Sciences and Humanities.

Binder, Harald. 2003b. Der nationale Konflikt um die Universität Lemberg. In *Position of national languages in education, educational system and science of the Habsburg Monarchy 1867–1918*, ed. Harald Binder et al., 183–215. Praha: Research Center for the History of Sciences and Humanities.

Borůvka, Otakar, ed. 1969. *Universitas Brunensis 1919–1969* [English edition]. Brno: Brno University Press.

Buszko, Jozef, and Irena Paczynska, eds. 1984. *Universities during World War II*. Warszawa–Kraków: Panstwowe Wydawnictwo Naukowe.

Connelly, John. 2000. *Captive University. The Sovietization of East German, Czech, and Polish higher education 1945–1956*. Chapel Hill: University of North Carolina Press.

Čornejová, Ivana, and Michal Svatoš, eds. 2001. *A History of Charles University I. 1348–1802*. Praha: Karolinum Press.

Ebel, František, ed. 1928. Deset let Československé republiky [10 years of the Czechoslovak Republic]. vol. I, 398–405. Praha: Press Department of the Government

Fasora, Lukáš, and Jiří Hanuš. 2009. *Masarykova univerzita v Brně. Příběh vzdělání a vědy ve střední Evropě* [Masaryk University in Brno. A story of education and research in Central Europe]. Brno: Masaryk University Press.

Gaweda, Stanisaw. 1981. *Die Jagiellonische Universität in der Zeit der faschistischen Okkupation 1939–1945*. Jena: Friedrich-Schiller-Universität.

Glettler, Monika, and Alena Míšková, eds. 2001. *Prager Professoren 1938–1948. Zwischen Wissenschaft und Politik*. Essen: Klartext.

Grüttner, Michael, et al. 2010. *Gebrochene Wissenschaftskulturen. Universität und Politik im 20. Jahrhundert*. Göttingen: Vandenhoek & Ruprecht.

Havránek, Jan, and Zdeněk Pousta, eds. 2001. *A History of Charles University II. 1802–1990*. Praha: Karolinum Press.

Hiio, Toomas, and Helmut Piirimäe. 2007. *Universitas Tartuensis 1632–2007*. Tartu: Ülikooli Kirjastus.

Konrád, Ota. 2009. Die Geisteswissenschaften nach den Umbruchsjahren 1918 und 1938. Die Deutsche Universität Prag und der Universität Wien im Vergleich. In *Wissenschaft macht Politik*, ed. Sabine Schleiermacher and Udo Schagen, 193–218. Stuttgart: Franz Steiner Verlag.

Konrád, Ota. 2011. Die tschechoslowakischen Hochschulen in den Jahren 1939–1945. *Acta Universitatis Carolinae—Studia Territorialia* 11:81–101.

Kostlán, Antonín, ed. 2004. Wissenschaft in den böhmischen Ländern 1939–1945. Praha: Koniasch Latin Press.

Kostlán, Antonín, and Alice Velková, eds. 2004. *Wissenschaft im Exil. Die Tschechoslowakei als Kreuzweg 1918–1989*. Praha: G plus G Press.

Lemberg, Hans, ed. 2003. Universitäten in nationaler Konkurrenz. Zur Geschichte der Prager Universitäten im 19. und 20. Jahrhundert. München: Oldenbourg Verlag.

Malý, Karel. 2009. Die Veränderungen der rechtlichen Stellung der Hochschulen in der Tschechoslowakei nach 1990 – der Weg zu ihrer Autonomie. In *Inseln der bürgerlichen Autonomie?* ed. Jiří Pešek and Tomáš Nigrin, 163–181. Frankfurt a. M.: Peter Lang GmbH.

Marek, Michaela. 2001. *Universität als "Monument" und Politikum. Die Repräsentationsbauten der Prager Universitäten 1900–1935 und der politische Konflikt zwischen "konservativer" und "moderne" Architektur*. München: Oldenbourg Verlag.

Mészáros, Andor. 2003. Maďarština na (buda)pešťské univerzitě a v uherském školství v 19. století [Hungarian as Language of Instruction at the University in (Buda)Pest and at Hungarian Schools in the nineteenth Century]. In *Position of national languages in education, educational system and science of the Habsburg Monarchy 1867–1918,* ed. Harald Binder, 169–182. Praha: Research Center for the History of Sciences and Humanities.

Míšková, Alena. 2007. *Die Deutsche (Karls-) Universität vom Münchener Abkommen bis zum Ende des Zweiten Weltkrieges*. Praha: Karolinum Press.

Míšková, Alena, Martin Franc, and Antonín Kostlán, eds. 2010. *Bohemia Docta. K historickým kořenům vědy v českých zemí*ch [Bohemia Docta. To the historical roots of sciences and humanities in the Czech Lands; English summary]. Praha: Academia.

Pánek, Jaroslav, and Oldřich Tůma, eds. 2009. *A History of the Czech Lands*. Praha: Karolinum Press.

Pasák, Tomáš. 1997. 17. *Listopad 1939 a Univerzita Karlova* [November 17th, 1939 and the Charles University]. Praha: Karolinum Press.

Pešek, Jiří. 2009. Die deutsche Universitäten 1945/46 und 1989/90: der schwierige und steinige Weg zur akademischen Autonomie. In *Inseln der bürgerlichen Autonomie?* ed. Jiří Pešek and Tomáš Nigrin, 21–53. Frankfurt a. M.: Peter Lang GmbH.

Pešek, Jiří, and Tomáš Nigrin, eds. 2009. *Inseln der bürgerlichen Autonomie? Traditionelle Selbstverwaltungsmilieus in den Umbruchsjahren 1944/45 und 1989/90*. Frankfurt a. M.: Peter Lang GmbH.

Pousta, Zdeněk. 2009. *Die Karls-Universität – die akademische Selbstverwaltung und der Staat. In Inseln der bürgerlichen Autonomie?* ed. Jiří Pešek and Tomáš Nigrin, 99–119. Frankfurt a. M.: Peter Lang GmbH.

Rüegg, Walter, ed. 2011. *A History of the University in Europe. vol. IV. Universities since 1945*. Cambridge: Cambridge University Press.

Schleiermacher, Sabine, and Udo Schagen, eds. 2009. *Wissenschaft macht Politik. Hochschule in den politischen Systembrüchen 1933 und 1945*. Stuttgart: Franz Steiner Verlag.

Seibt, Ferdinand, ed. 1984. *Die Teilung der Prager Universität 1882 und die intellektuelle Desintegration in den böhmischen Ländern*. München: Oldenbourg Verlag.

Šimůnek, Michal, and Dietmar Schulze, eds. 2008. *Die nationalsozialistische "Euthanasie" im Reichsgau Sudetenland und Protektorat Böhmen und Mähren 1939–1945*. Červený Kostelec: Pavel Mervart Press.

Stopka, Krzystof, ed. 2000. *The history of the Jagiellonian University*. Kraków: Jagiellonian University Press.

Štrbáňová, Soňa, and Antonín Kostlán, eds. 2011. *Sto českých vědců v exilu. Encyklopedie významných vědců z ČSAV v emigraci* [One hundred Czech scholars in Exile. Dictionary of foremost Czech Émigré scholars Coming from the Czechoslovak Academy of Sciences; Summary in English]. Praha: Academia.

Surman, Jan Jakub. 2012. *Habsburg Universities 1848–1918. Biography of a space*. Wien: Universität Wien, Dissertation.

Svobodný, Petr. 2004. Neue Menschen, neue Disziplinen. Die deutsche Medizinische Fakultät in Prag 1939–1945. In *Wissenschaft in den böhmischen Ländern 1939–1945*, ed. Antonín Kostlán, 143–163. Praha: Koniasch Latin Press.

Svobodný, Petr. 2005. Dieselben Leute – neue Karrieren: Die Schicksale von Hochschullehrern der deutschen medizinischen Fakultät in Prag nach 1945. In *Magister noster*. Fetsschrift in memoriam Prof. PhDr. J. Havránek, CSc., ed. Michal Svatoš, Luboš Velek, and Alice Velková, 261–274. Praha: Karolinum Press.

Svobodný, Petr. 2009. Prague Faculties of Medicine and their Clinics in 1939–1945. In *Wissenschaft macht Politik,* ed. Sabine Schleiermacher and Udo Schagen, 219–228. Stuttgart: Franz Steiner Verlag.

Svobodný, Petr. 2011. Wanderungen und Wandlungen: Die medizinische Fakultät der Deutschen Universität Prag und ihre Beziehungen zu deutschen und österreichischen Universitäten in den Jahren 1882–1945. In *Zehn Jahre Universitätspartnerschaft Univerzita Karlova v Praze – Universität zu Köln*, ed. Walter Pape, 15–30. Köln: Universitäts- und Stadtbibliothek.

Tayerlová, Magdalena, ed. 2002. *Česká technika/Czech Technical University* [Czech and English edition]. Praha: Czech Technical University Press.

Urbášek, Pavel, and Jiří Pulec. 2012. *Vysokoškolský vzdělávací systém v letech 1945–1969* [University Education System in 1945–1969]. Olomouc: Palacký University Press.

Vykoukal, Jiří. 2009. Die polnischen Universitäten 1945–1948: Autonomie, Wiederaufbau und Politik. In *Inseln der bürgerlichen Autonomie?*, ed. Jiří Pešek and Tomáš Nigrin, 121–147. Frankfurt a. M.: Peter Lang GmbH.

Wirbelauer, Eckhard, and Norbert Schappacher. 2010. Zwei Siegeruniversitäten: Die Straßburger Universitätsgründungen von 1872 und 1919. *Jahrbuch für Universitätsgeschichte* 13:45–72.

Wróblewska, Teresa. 2000. *Die Reichsuniversitäten Posen, Prag und Straßburg als Modell nationalsozialistischer Hochschulen in den von Deutschland besetzten Gebieten*. Toruń: Adam Marszalek Press.

Zilynskyj, Bohdan. 2009. Die Erneuerung der Tätigkeit der Universitäten in der Ukraine. In *Inseln der bürgerlichen Autonomie?*, ed. Jiří Pešek and Tomáš Nigrin, 149–162. Frankfurt a. M.: Peter Lang GmbH.

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Part II
Universities in diverse political contexts

Chapter 8
University Models in Changing Political Contexts

Gabor Palló

The history of Hungarian universities shows that politics can be an intrinsic rather than extrinsic force in university reforms. Politics can be much more important than as just one of the elements of the complex circumstances under which a university has to work. This is probably quite often the case but in Hungary the peculiarity of the situation was that foreign powers enforced the local authorities to introduce university models instead of being compelled by various internal forces in compromising negotiations. This enforcement might have been an important reason why the universities have been considered to be politically highly sensitive places in the last 150 years in Hungary, a period that was full of radical social and political changes.

Enforcement of a university model has largely been overlooked in the literature. Analyzing the forms of modern European university, some authors assume that structural changes in their models have somehow been determined by the requirements of the growth and differentiation of knowledge. Politics, cultural and economic circumstances or demands deeply influence the changes in the historical forms of the university but knowledge is the fundamental factor.

This is the starting point of the comparative analysis in Ben-David's seminal studies on the basic forms of European universities, notably the French, British and German forms (Ben-David 1977). He explains, for instance, that by the beginning the twentieth century, the German university as an institution could not cope with the problems of fast-emerging new scientific specialties, such as electrochemistry and many others that combine different fields. The institutional structure of the German university was not flexible enough to provide space for them. The system of such a university was based on large institutes and chairs constituting a rigid structure. According to Ben-David "a kind of class tension was built up within the established fields, there was increasing resistance to the institutional position for the cultivation of new fields. … There were obstinate and long, drawn-out debates about theoretical importance of new fields to justify the establishment of any new

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chair" (Ben-David 1971, p. 132). Hence it was extremely difficult to set up a new chair. Ben-David considered this rigidity the main reason for the decline of the German-type university. As he said, "Because of the internal tensions between the ranks and the difficulty of obtaining recognition for new fields, the center of scientific activity … started to shift to Britain and the United States." (Ben-David 1971, p. 137).

The changes of model at Hungarian universities, however, did not have much to do with the requirement of growing knowledge. From the large literature, including the comprehensive *History of the University in Europe* edited by Hilde de Ridder-Symoens and Walter Rüegg, we can learn a lot about the political and intellectual contingencies in the early years of the nineteenth century, which gave birth to the German model itself (Ridder-Symoens 1992–1996; Rüegg 2004). Indeed, in the introduction Rüegg explains how some aristocrats, such as Baron Karl vom und zum Stein and Count Karl August von Hardenberg fought for the modernization of state administration on the one hand, and how a group of philosophers, including Johann Gottlieb Fichte, Friedrich Schleiermacher, and Wilhelm Friedrich Hegel demanded to modernize education on the other. Meanwhile, French troops threatened the Prussian state and for a while Wilhelm von Humboldt held a high governmental position. All these coincidences appeared to be necessary conditions for the birth of the Humboldtian University (Rüegg 2004, pp. 22–23).

There is widespread agreement in the literature about the fundamental role of social factors in the formation of modern university, like the birth of nation states, industrialization, modernization of state administration, and the like. Jarausch emphasized this in several papers, including one on the role of professionalization (Jarausch 1990), a process that was analyzed in detail using the example of chemistry by Jeffrey Johnson in the same volume (Johnson 1990).

These influences had been present in Hungary in the nineteenth century but they did not cause substantial tension leading to the complete restructuring of the universities. Internal evolution did not result in the introduction of a model.

8.1 Modernization and the Habsburg Rules

Modern university, in particular the German model, had been introduced in Hungary during the Austrian neo-absolutism that was established in 1849. At the time of the establishment of Berlin University, in 1810, Hungary existed as part of the Habsburg Monarchy. In the late eighteenth century, however, Hungarian nationalism awoke and evolved very strongly. A group of people (called the reform generation in the historiography) consisting of musicians, poets, writers and language reformers held meetings, organized civil movement circles, published books, and later newspapers expressing emotions or convictions on the values of being ethnically Hungarian. A romantic idea arose about the origin of the Hungarian nation, and about its heroic past and strength. Nationalism gradually turned against both the ethnic minorities living in Hungary, like Slovaks, Serbs, Romanians and others, and also against the Habsburg rulers. In 1825 nationalism led some Hungarian aristocrats and landowners to decide on the establishment of the Hungarian Academy of Sciences with the goal of creating a Hungarian scientific language and spreading scientific knowledge into the wider circle of the population. The academy was a learned society, not a university that worked in a traditional framework without being considered to be a very important institution in the horizon of the nationalist reform movement. National theatre national museum and national academy were symbolic institutions of the endeavor but the Hungarian university was not.

Industrialization also started at the beginning of the nineteenth century. In Hungary, a traditional agricultural society with huge estates, industrialization started in the food industry (such as production of sugar or alcohol), and in the modernization of mills, and transportation. Management of agriculture also needed technical and economic experts but the demand was weak. The university produced doctors, lawyers or clerical people, it taught botany, zoology, physics or chemistry in the traditional framework without any pressure of structural change. Some tasks, like building new roads, drying out swamps, regulation of rivers and measuring the borders of estates raised some demand for engineers. This demand led to the setting up of an engineering school in the university, called Institutum Geometrico-Hydrotechnicum, which worked between 1782 and 1850.[1] Its statutes explicitly referred to roads, swamps and rivers, without mentioning machines or industries in general.[2]

The work of the reform generation, the fast progress of nationalism, and the wish of modernization led to a revolution in 1848 that ended up as a freedom fight against Austria and the Habsburg rule. In 1849 Austria defeated Hungary with the help of the Russian army, executed and imprisoned the leaders of revolutionary fight and introduced an absolutist rule, leaving out the Hungarians from decision-making. Hungary remained a part of the Habsburg Monarchy with hardly any independence.[3]

8.2 German University Model

The defeat, which deeply hurt nationalistic feelings already existing in the Hungarian populations, indirectly resulted in the realization of a big part of the modernization program, including modernization of the school system, which the reform generation had largely been ignoring since the late eighteenth century. Austrian Emperor Franz Joseph I declared that he was responsible to God and not to the people of his empire. He worked according to his views without discussing them with politically legitimized bodies. Besides introducing censorship, building up a large network of secret police spies, his regime strengthened the power of the Catholic

[1] Institutum Geometricum seems to have been the first engineering school working in the framework of a university in Europe.

[2] The goals and complicated history of this institution had been detailed by Ferenc Fodor (1955).

[3] This short historiography can be considered to be the standard historical narrative of the time. About the history of Hungary there are some useful books in English language, see Sugar et al. 1994, Kontler 2002, or Evans 2006.

Church and intended to unify the whole multiethnic empire by Germanizing it. For this reason it was mandatory to use German as the official language in all parts of the whole empire. As a part of this political framework, Alexander Bach, minister of internal affairs, reorganized the whole public administration, and put Austrian state officials into the important offices in Hungary. These officials directed and worked with Hungarian administrators. In the period of 1850–1859, the public administration went through a process of professionalization.

Education was another central part of the Germanizing unification. Austrian minister Leo von Thun-Hohenstein was responsible for introducing a uniform educational system throughout the whole empire, including Hungary. The conservative catholic Thun entrusted the Austrian-born philosopher, Franz Exner to work out the blueprint. Exner, a protestant professor of philosophy at the University of Prague was a follower of the German philosopher and educator Johann Friedrich Herbart and an adherent of the German-type university. He suggested reforming the Austrian universities in the line of Wilhelm von Humboldt views, meaning, copying the structure of the Berlin University opened in 1810.[4] Thun pressed Exner's draft through the Austrian political and catholic ideological resistance and convinced the emperor to sign it.[5]

The irony of this history is that the most modern university model, which spread all over Europe was introduced into Hungary by Franz Joseph, the head of an extremely conservative administration. Right after the Austrian victory against the Hungarian fighters for national independence, in 1849, Thun started to circulate the order to all higher education institutions in the empire, saying that they must restructure their work according to the 25 paragraphs of the order prescribing the new organizational rules of the universities.[6]

The order contained the most important principles of the Humboldtian model, including academic and teaching freedom. Unlike the traditional university that aimed to educate servants of the state, the churches or higher nobility classes, the new university purported to produce free thinkers. The university becomes the seat of free scientific research. Students were supposed to cooperate with professors as colleagues not as subordinates to produce new knowledge. This was secured by the autonomy of the university, the exclusive right of professors to administer the university, instead of being governed by state or church. It was the students' right to choose the subjects they wanted to study and to professors with whom they wanted to study and work. The state kept the right to supervise the work of the university

[4] Exner produced another very important document concerning the reform of high schools. The German university pattern could be introduced if the basic skills were taught before they entered the university. In order to acquire the skills the student had to graduate from appropriate schools, the gymnasiums. Exner worked out the plan of introducing the German (basically Prussian) high school in his Entwurf der Organisation der Gymnasien und Realschulen in Oesterreich, a document that provided the basis of high-school reform throughout the empire (Austria Ministerium für Cultus und Unterricht 1849).

[5] Concerning the history of Hungarian universities, I relied on Szögi 2001, 2003 and Bíró 1990.

[6] This was the often cited Nr. 6798, 1849: order of the emperor, see for instance Rácz 2010.

and appoint the civil servant professors proposed by the university. These principles were included in Thun's order.

The reorganization of the Hungarian universities according to the German pattern progressed gradually for many years but the outlines were laid down in the order issued in 1849. The university was divided into faculties, and chairs: one discipline, one chair. The Hungarian university had four faculties: law, medicine, philosophy and theology. In the new system the rector became the head of the university and the dean directed the faculties, unlike the various directors of the previous organization. The leaders had to rely on the University Council and the Faculty councils that were ordered to be set up. All of them had to be elected from the professors, unlike in the old regime. In principle the new leaders were elected by the professors but in Hungary, in contrast with other parts of the empire, it was the emperor's all-powerful commissioner (Count Károly Geringer until 1851, later Prince Albrecht Friedrich Rudolf von Österreich-Teschen) who appointed them. In this model the body of the university consisted of two types of professors, ordinary and extraordinary (both were appointed by the state), and in some faculties of adjuncts and assistants.

Another group belonging to the body of the German-type university was the 'privat dozents', non-faculty teachers. They were not civil servants but unpaid, mostly young people having earned the right to teach special subjects in the hope of becoming the successors of the professor. The right to teach, called "venia legendi", could be received after an evaluation process called habilitation.[7] In Hungary the history of non-faculty teachers goes back to the early nineteenth century, but habilitation became gradually a regular part of the university life from 1850 with the fully introduced German model (Biró 1990).

Besides the principles of freedom and unity of teaching and researching, and the organization pattern, the German-type university, had a spiritual goal based on philosophical and cultural views. This widely discussed component was called *Bildung*, which translates to education contrasted with training. This means that this university intended to transmit more than professional knowledge. It also aimed to transmit special moral, cultural and political values, and to prepare students to take a special role to be played in German society. By Bildung the university hoped to produce a special group of people who serve their society according to the complex norms they acquired at the university.[8] These moral and cultural values originated in the late eighteenth century German culture and philosophy.[9]

[7] The history, description, structure and work of the German University can be found in a great number the books including the works of Ben-David 1971, 1977, Rüegg 2004 or Jarusch 1990, cited above.

[8] This is why Björn Wittrock and Sheldon Rotthblatt suggest differentiating between the terms of 'university' and 'higher education'. 'University' means the spiritual unity of the faculty members and their graduates, whereas 'higher education' means simply transmitting knowledge (Rothblatt and Wittrock 1993). In this paper I use 'university' in both senses without this differentiation.

[9] The romantic, natural philosophy ideas and morality influenced the history of the academic community at least as much as the organization pattern. 'Mandarins' is what Ringer calls the German professors who represented this idealist philosophy and moral. They exerted great influence on politics, moral, and intellectual norms and they achieved enormous results in many intellectual

The Bildung aspect of the German university might have contributed to Thun's idea of using the German university model for contributing to the unification of the empire. However enlightened and free thinking this model was, the authoritarian political control could be exercised at the university without any difficulty. The old name of Universitas Regia Budensis (Royal University of Buda) was changed to K. K. Universität Pest (Imperial and Royal University of Pest).

The most obvious area of direct influence was the choice of the personnel of the university. As the government had the right to appoint its civil servants, the Habsburgs employed Austrian professors at the Hungarian university who did not even speak Hungarian, only German. The authorities referred to the mandatory German official and teaching language throughout the empire. In addition, as the vacant positions were advertised in the whole empire and some parts of Germany, other non-Hungarians could also earn appointments in the hope that they would not support Hungarian nationalism rather they would be loyal to the Habsburgs. For instance Friedrich Maassen, Eduard Schwab and Moritz Schach received chairs in the faculty of law, Emanuel Seich became professor of surgery, Karl Langer professor of zoology, along with many others (Sashegyi 2003).

All these acts could be interpreted as having been done in the name of Bildung, i.e., with the aim of educating a Hungarian intelligentsia loyal to the Habsburgs. The emphasis on Bildung, however, belonged to the past for the Humboldtian university in 1849. As Wittrock says, the German model went through a second transition after the first that occurred at the turn of the eighteenth and nineteenth centuries when the traditional university changed to the Humboldtian one. The second transition in the mid-nineteenth century resulted in a shift from Bildung to professional scientific research and specialization of disciplines, contrasting with the earlier period's ideal of unity of knowledge, collectivity, and rule of morals (Wittrock 1993). The same process came about in the field of teaching. With disciplinarization, knowledge production and transmission became more expected from the universities and they occupied an increasingly more important role in their activity than Bildung, although the idea of education, i.e., production of loyal citizens and an intellectual elite has remained connected with idea of university throughout its history.

The Hungarian university was organized according to the spirit of second transition rather than to the original romantic ideal. As Hungary's modernization progressed, the market of experts grew and the reformed university proved to be useful in many areas, such as law, economy, agriculture, and medicine. It served the goals of modernizing Hungary for a long period of time, although the political circumstances changed radically. In 1867 Hungary and Austria came to a historic compromise establishing the dual Austro-Hungarian Monarchy. After this the official and the teaching language changed to Hungarian and Hungarian professors occupied the chairs and the leading positions.

After the First World War the dual Monarchy dissolved and Hungary became an independent country; however, belonging to defeated side, Hungary lost a major

fields in Germany from the last decades of the nineteenth century. Their complex activity, however, contributed to the Nazi tragedy in Germany (Ringer 1969).

part of its territory and population in the Trianon peace treaty. In 1919, during the short-lived communist rule, new professors were appointed to the university, many of them outstanding scientists, such as the chemists George de Hevesy, Michael Polanyi, and others. But in 1920, after the communist regime was deposed, most of these new professors were promptly dismissed for political reasons. Later they became exceptionally successful outside Hungary. In addition, in 1920 an anti-Semitic policy was implemented resulting in screening out Jewish students and professors. The radical political changes impacted the university soon and harshly but they did not touch the basic Humboldtian structure.

8.3 The Soviet Model

The German model was discarded after the Second World War, after the Soviet army occupied Hungary, just as the Austrian army did about 100 years earlier. The Soviet army stayed in Hungary until 1990. The Soviets forced Hungary to introduce a new university model by ordering Hungary to use their state socialist system in all areas of social life, including higher education.[10] Budapest Technical University exemplifies the process of introduction and the work of the Soviet model of higher education. Other institutions had to apply exactly the same scheme. The Technical University is a good example because it was considered less sensitive from the ideological point of view than, for instance, a faculty of humanities.

All this happened after 1945, when Hungary was defeated as an ally of Nazi Germany and the Soviet army invaded. The country suffered much. Hungary lost around 1 million citizens, 6.5 % of the population (including around 500 thousand Jews who were killed inside and outside Hungary), and about five times of the GDP produced in 1938, the last year before the war.[11] Huge masses were forced or decided to leave the country and many were deported to labor camps in the Soviet Union. The society was divided. The majority felt that a wild ‘Asian’ army occupied the country; others, including the Holocaust survivors, hoped for a radical change to the hopeless political, economic and social structure that characterized the prewar years.

In 1948 the Stalinist social and economic regime was fully introduced into Hungary. In this regime the communist party ruled all the social systems without any political opposition. Parliament was degraded to a formal venue of legal procedures without any real power. A single party, the Hungarian communist party (officially Hungarian Workers’ Party) was permitted to work without any opposition parties in parliament. Unlike in the mid-nineteenth century, Hungary remained formally (*de jure*) independent. It had a constitution and a legal system. The members of

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[10] To help understand Soviet science, there is an enormous literature to read. A very good start for the subject is to consult books by Loren Graham (e.g. 1972, 1994).

[11] These data are summarized in a table in a comprehensive book on the history of twentieth-century Hungary (Kollega Tarsoly 1996–2000).

the government and the heads of the most important offices were Hungarians, and the language was Hungarian. However, all state institutions were controlled by the communist party, which had organizations headed by party secretaries in all workplaces, including factories, universities, theaters, agricultural cooperatives, everywhere. The party had a hierarchical structure. The members had to carry out decisions made by higher-level bodies. To be a party member had advantages: members were considered more reliable than others; hence many jobs could only be occupied by party members. According to Mathias Rákosi, head of the party, the number of members reached 800 thousand by 1948 (Rákosi 1951), and remained around 1 million, not more because the leaders were afraid of having too many untrustworthy party members in an even larger mass.

The Soviet control was carried out by carefully selected and directed people. Leaders of the Hungarian communist party, including Rákosi, spent decades in the Soviet Union; they were called Muscovites. They were faithful to the Soviet Communist Party, in particular to Stalin, under all circumstances. Although seemingly they came to power in a democratic election, their election was in fact manipulated. There was no real legal basis for this administration. Therefore, the political leaders depended on Soviet power instead of their voters. Soviet party officials gave direct orders, or sometimes indirect indications to the Hungarian party leaders concerning measures to be taken.[12] The organization of the state, foreign policy, economy, social restructuring, the work of secret police, and all parts of social life was dictated by the Soviet Union relying on the power of its army that stayed in Hungary. The control was extended to the citizens' thinking by introducing an ideology, called Marxism-Leninism at all levels of life.

Legal rule absent, individuals and their informal relations became extremely important in social, political and cultural life. These relations were assisted by a powerful secret police, a network of civilian informers recruited by various means including corruption and threat. Party secretary Mathias Rákosi, Stalin's Hungarian 'reincarnation' stood at the top of the hierarchy. For participating in the short-lived Soviet republic in Hungary in 1919 and in the banned communist movement during the interwar period, in 1924 Rákosi was imprisoned for 16 years. In 1940 a Soviet diplomatic intervention freed him and brought him to the Soviet Union to join his comrades, who had also had to emigrate from Hungary in the 1920s. He returned in 1945 to become the leader of the communist takeover.[13] His most important associate was Ernö Gerö, who as a member of the Hungarian communist party moved to the Soviet Union in the 1920s. Gerö became an agent of NKVD (secret police, predecessor of KGB), occupied important positions in the Third Communist International (Comintern) and was the Comintern representative in the Spanish Civil War in the 1930s.[14]

[12] About Hungarian history in the last century in English language see Romsics 1999.

[13] There is no biography written by a professional historian. Journalist, Árpád Pünkösti has written several books and papers on Rákosi's biography (e.g., Pünkösti 1992).

[14] To my best knowledge there is no lengthy biography about Gerö. I relied on the entry of a biographical lexicon (Kenyeres 1994).

In Hungary, Gerö became the highest leader responsible for economic and technological matters in the Stalinist period. The training of engineers and the work of science were under his authority as far as these matters had direct relations with economy in the Stalinist structure. The direct relationship between training engineers, science and economy was based on the work of economy that was organized by central planning contrasted with spontaneous market forces. On the party's order an office, called the Central Planning Bureau, worked out an economic plan for a certain period, mostly for 5 years. For instance, in 1950 the government decided that the economy should grow by 86 % in 5 years, which was soon modified to 310 %, and heavy industry should grow by 380 % in order to restructure the production of agrarian Hungary into an industrial economy (Pető and Szakács 1985). The task of the plan-making economists was to calculate the planned targets (scheduled output) for all individual economic agents. For instance the plan said that A tons of steel should be produced; for this B tons of ore should be mined, C electric energy should be generated, D buildings should be built, F, G and H workers should work in this or that factory, in the energy sector or in the construction industry. In the workplaces all people had their own plans, called 'norms' that prescribed how many bricks they had to lay, how many screws they had to produce. The workers were arranged into brigades, in which they cooperated and collectively contributed to the production of the company. The brigades had their own plans.

Central planning and the whole procedure were extended to science and education. In 1948 a governmental institution was established called the Hungarian Council of Science. Its task was to establish a new institutional system for science harmonious with the socialist model of the society and with Marxist-Leninist ideology. Although the Council of Science had its own leadership consisting of scientists, it was directed by the Party-collegium headed by Gerö. Yet at the end of 1949 the Soviets ordered the Council of Science to be dissolved and the Hungarian Academy of Sciences to be reorganized this to become the center of scientific research exactly in the same way as it works in the Soviet Union (Huszár 1995, Kónya 1998). The same shift was carried out in the other satellite countries, leaving no space for national tradition in the organization of science (Palló 1993). The Party-collegium complied. On July 2, 1949 it was decided that "it is a proper general principle to divide teaching and scientific research from each other. The most excellent material (probably persons—G.P.) should be directed toward scientific research."[15] This was the termination of the Humboldtian model that based the unity of teaching and research in universities. In the Soviet model a network of research institutes were formed with the task of doing research without any teaching duties.[16] Simultaneously universities had to be reorganized to fulfill their task of teaching without doing scientific research.

[15] Archives of the Hungarian Academy of Sciences, Papers of the Council of Science, 1/8.

[16] In fact the reorganization of the Academy and the establishment of the institutes was a long process detailed in Kónya (1975).

8.4 Technical University, from German-Type University to Socialist Factory

The Technical University of Budapest was also a German-type university until 1949. It was based on Humboldtian principles of freedom and unity of teaching and research, with a German-type organization pattern: university and faculty councils, rector and deans, faculties and chairs, civil servant ordinary and extraordinary professors, plus private docents. It grew out from the Institutum Geometricum, the engineering school established in the late eighteenth century at the Hungarian University. After being degraded to an industrial school, it was gradually raised to university level in the dualist Austro-Hungarian Monarchy.[17] At this new start the technical university had faculties of general engineering, mechanical engineering, architecture, chemistry, and philosophy (later 'general faculty'). This latter faculty produced teachers for the "Realschule", the new modern type of high school. Later, new faculties were established, including of economics, agriculture, and others.

During Soviet times, besides the separation of teaching and research, the most important digression from the German model was the introduction of central planning into the work of the Technical University. This was the starting point of the Soviet model's work that reshaped the university into an institution similar to a socialist factory. Instead of educating or training people with ambitions to become engineers, this university had to produce engineers for realizing the plans of industry. The extremely fast growth of industrial production needed the same growth in the numbers of engineers. Never in Hungarian history did engineers play such an important social and ideological role as during Stalinism.

Some statistical data characterize this fast growth. For instance, between 1949 and 1953 the number of students at the Budapest Technical University increased very sharply to about 14 thousand by 1953 as compared with about 4000 in the late 1940s (Fig. 8.1). By 1960 the university doubled its size in terms of square meters (Fig. 8.2). The number of faculty staff became 4.5 times larger than it was in 1938, the last peace year before the Second World War (Fig. 8.3). In addition, new technical universities were also organized in and outside Budapest.

How did the socialist factory-like university work in practice? First of all, the faculty was the worker in a Socialist factory-like university. The university needed many teachers to meet the demands of the plan. The political screening of university staff after the Second World War was not very strict because the university leaders wanted to keep the professors even if they had good relations with previous regime. Characteristically, the first rector of the Technical University after the war, Györzö Mihailich, a civil engineer and a well-known former supporter of anti-Semitic student movements, was almost screened out by a committee for war crimes, but because he was an important expert on building bridges, Gerö saved him. On the other hand, many new teachers were employed who were politically loyal to the new

[17] According to its historian, Ferenc Szabadváry, this was the first engineering school in the history of higher education that had 'university' in its name (Szabadváry 1982).

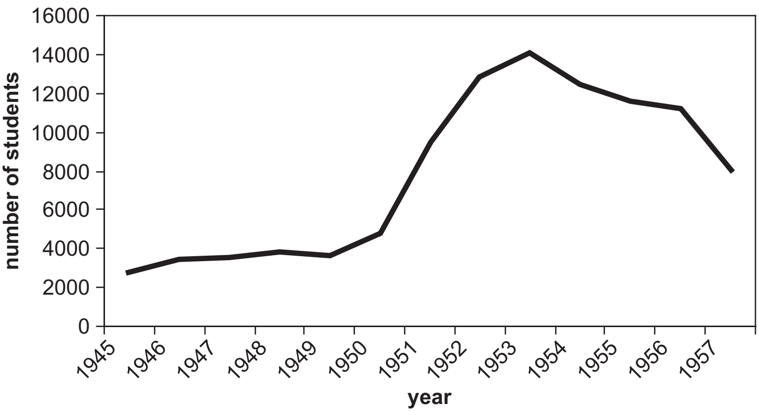

Fig. 8.1 The number of students at the Technical University of Budapest. (Source: Héberger 1979, pp. 1753–1754)

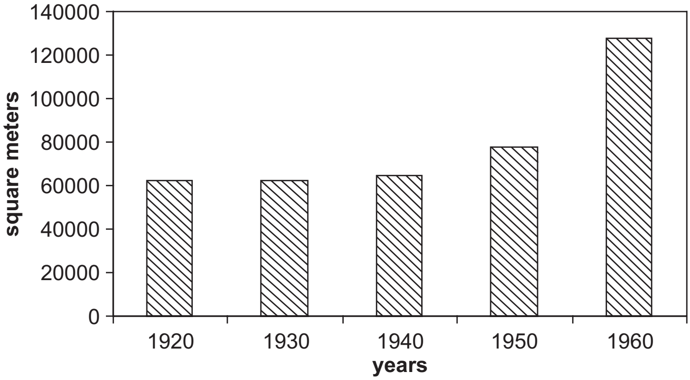

Fig. 8.2 The surface area availability for training and research in the Technical University of Budapest. (Source: Héberger 1979, p. 1771)

regime. In addition, like in the Habsburg times 100 years earlier, the Soviet rulers sent their experts to chairs and to offices in order to help the Hungarians introduce their model. M. G. Efimov, V. O. Artunov, P. I. Sapozkov, A. P. Sobolev, N. G. Potapov, and many other Soviet professors spent some years in various Hungarian universities.[18]

This was the time of unbelievably fast university careers, when people in their late twenties could become full professors. For instance, Károly Polinszky, chemical engineer joined the communist party in 1948, when he was 26. Next year he was asked to set up a new research institute and a faculty of the Budapest Technical

[18] The number, role and activity of Soviet experts have not yet been studied. The names in the text came up accidentally in various historical texts.

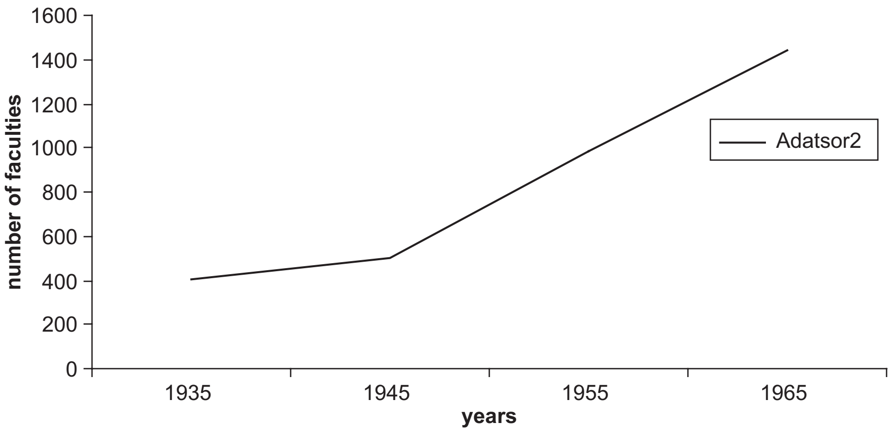

Fig. 8.3 The growth of the faculties at the Technical University of Budapest. (Source: Héberger 1979, p. 1765)

University in Veszprém, a town northwest from Budapest. In 1951 this became an independent university of heavy chemical industry, one of the higher education institutions specializing in a relatively narrow field. Polinszky later became full professor, director of a research institute, dean, rector and even a minister of education (Benedek 1999).

The establishment of new, independent but very specialized universities that produced experts in well-defined fields was a characteristic feature of the Soviet model. Accordingly, some faculties or specialties were cut from the technical university to become independent universities in their own rights. A university of agriculture, university of economics, university of heavy industry, university of architecture, university of transportation, and others were established in the late 1940s, early 1950s. Overspecialization was another step away from the original Humboldtian idea of the unity of knowledge.[19]

Central planning had to admit enough new students, the raw material to be processed in the factory-like university. As the government could not abruptly establish hundreds of new high schools with teachers and infrastructure to train high-school graduates and even if they could, it would have taken years until they finished school, it was necessary to recruit students without high-school graduation. Young workers and peasants were pushed into universities in order to meet the requirements of the plan. At the beginning, short courses were organized for these poorly educated people to provide them with high-school matriculation in 1 year. Later, when the university needed even more students, workers without any high-school graduation were also enrolled at the Technical University.[20]

[19] Bukharin's Stalinist philosophy of science underlies this policy. This philosophy says that all kinds of scientific research should have direct practical relevance, 'pure science' belongs to the surpassed bourgeois society.

[20] The problem of handling students without proper high school graduation permeated the work of the whole higher education and the solutions were almost the same in all institutions. Its

The road leading to the Socialist factory-like university proved to be rough due to the unprepared students. The number of failed exams and dropouts were enormous. At the end of 1950, the university's communist party secretary Tibor Ormos noticed at a meeting that "150 students, mostly freshmen, 33 special high-school graduates among them, disappeared from the university."[21] As a result, only about 7% of the Budapest Technical University students would finish their studies in the prescribed 4 years, while it took 5–7 years for 67%, and more than 7 years for 26%.[22]

The problem was so significant that Mathias Rákosi, then secretary general of the communist party, had to intervene. He attributed the difficulties to excessive university standards. Meeting these requirements overburdened the students. Rákosi said that the enemies of people demanded too much from them "to force out a significant part of the proletarian students from the universities" (Ladányi 1986, p. 22). The university leaders complied and decided to strengthen the discipline.[23] This sounded menacing. The Party secretaries implicitly blamed the teachers for sabotage against their policy by not transferring knowledge effectively, not helping the students pass their examinations. In worse cases they were blamed for being hostile to Socialism, an accusation that could lead to long prison sentences under the Communist dictatorship.

As a consequence, the matter of dropout and of failing examinations had become a politically sensitive issue. The university had to solve the problem by all means.

First the whole university administration had to be reorganized. The bureaucratic control and the parallel political control became very strong. With the huge, overworked, "very important" administrative staff the university seemed similar to any other factory. New sections were set up called 'Office of Study' to take care of the work of students. The office's activity was based on statistics like plan departments in factories. Their responsibility was to enforce the realization of the plans developed at the desks of the central planning office. [24]

Another factor was the shortage of textbooks. As a consequence, a rich, blossoming textbook and lecture note literature was born; some items became classics in their fields (Palló 2000, pp. 383–385). This measure improved the situation.

Classroom activity also had to go through a profound change. In the old German system professors delivered their lectures in large lecture halls for all students whose curriculum contained their subjects. The students made notes of the lectures and these notes were used to prepare for the examinations. The lectures were supplemented by seminars and laboratory practices. This system could not work at

appearance at the Technical University had been described in Héberger 1979, p. 1180 and 1183.

[21] Protocols of the Council of Rector meetings (PCRM), December 18, 1950. Technical University (TUB) Archive 1.

[22] Feljegyzés (Memorandum) Országos Levéltár, OL (National Archive), XIX-i-1-r/23 (without date).

[23] PCRM, February 21, 1951. TUB Archive 1.

[24] A note came to the university 1 day saying that "The offices of study are the executive organs of the proletariat's dictatorship." (Héberger 1999, p. 1176)

the Socialist factory-like university because the graduates of 1-year high schools and the worker students did not have enough preliminary knowledge to follow the lectures. Yet, this particular group was meant to be the core of the new loyal Socialist intelligentsia.

The big size of classes was assumed to be fashioned for well-prepared, non-proletarian students, and to prevent many students from following the lectures. Hence, the university authorities solved this problem by dividing the classes into smaller study groups of around 20 students. They worked as the brigades in the Socialist factory. The study groups were placed in smaller rooms and each group had a young faculty member responsible for the results achieved in tests and exams by the students belonging to his group. This young teacher worked like a headmaster. He also had to help backward students in all manner of their studies, including filling in the gaps of their missing basic knowledge. The members of the study groups were supposed to work together. The more successful students were expected to assist the less successful ones and the young faculty member controlled their cooperation. The study groups became the sites of learning, of community life, which was much emphasized at that time, and they also gave good opportunity for political influence and control.

This was a supplement to the Stalinist version of Bildung, a component of the original Humboldtian model that survived with a changed content. At the Technical University, as at all universities, ideological education was compulsory, disregarding students' convictions or their communist party membership. From 1950 chairs of Marxism-Leninism were organized and all students had to pass exams in the official ideology. To study Russian language became mandatory. Though it was not used as a teaching language, it was regarded a foreign language that everyone must know.

Overburden was enormous. The preparations for the tests, exams, the drawings, the consultations gave sometimes 50–55 h class work per week for the students and even more for the teachers who also had to handle evening and correspondence courses.

Here we have the Socialist factory-like university. The Humboldtian principles had long been forgotten. The university was to produce specialists to contribute to the economic plan, while research was organized into an independent system of institutes around the Academy of Sciences. Academic freedom, freedom of teaching, free cooperation between excellent students with great professors belonged to the past. The strange consequence was that the model worked. The university produced engineers who could finally fulfill their tasks in the centrally planned state-Socialist industry.

After Stalin's death in 1953 the rigor of the model gradually eased but its basic structure and work lasted for a long period. Meanwhile, a new university model, the American one, gained influence in a large part of the world. This model gradually took shape from the early twenieth century as a result of the work of among many others, educators such as Abraham Flexner and philosophers like John Dewey. The model relies on a horizontally organizational structure of departments contrasted with the hierarchical principle of the German model. Several professors heading laboratories can work parallel in a department providing opportunities to new emerging subfields. The professors are not civil servants rather employees of the university. In addition the central value of this model is training as opposed to the idea of Bildung in the German type university. Instead of creating intellectuals who create values and are loyal to the state, the American type university aims to train experts who have a good chance to be successful in the knowledge market. The American structure is more flexible and more effective than the German one; it can follow faster the changes in demand emerging both in the knowledge and teaching markets.[25]

Concluding Remarks

The two cases analyzed above illustrate the decisive role of general politics in university life in Hungary. During the investigated period of about 100 years, roughly between 1848 and 1950, Hungarian society was coming to grips with the task of modernization. In general, this complex process had many social, cultural, political, economic, technological, sociological, and other components, including a growing demand for knowledge required by industrialization, state administration, banking, medicine, agricultural technologies, management, and many other things. This process provided many reasons for introducing new university models in various countries. Another kind of reason was related to the growing knowledge, its unavoidable specialization and disciplinarization, which changed the economy of knowledge transfer. Many authors, including the cited Ben-David, Rüegg, Witrock and others placed the historically changing university models into this complex context.

In Hungary, however, the modernization process did not lead to an endeavor to restructure the university. It was an imperialistic effort of the Austrian empire in the nineteenth century, and of the Soviet empire in the twentieth century, which forced the introduction of new university models. Hence, the introduction of both the German and the Soviet models in Hungary served rather the imperialistic goals of non-Hungarian political powers existing in those times in different geographic regions, having entirely different cultural, political, and ideological visions. The university was one of the instruments of their reign, disregarding the demands of the ruled society's internal demands.

There is no historical evidence that would indicate that the Soviets had learnt anything from the approach of the Austrians but it still looks as if they copied it. Both powers justified the necessity of introducing a new university model in Hungary by the unity of their empire. They sent their representatives to Hungary to show the Hungarian professors and administrators the work of the model. In both cases the usage of the intruder's language was mandatory, although in the Soviet era the official and the teaching language remained Hungarian. In addition, a main idea of the original Humboldtian university, Bildung, meaning education to become a loyal intellectual, a representative of the moral and cultural ideal of the given

[25] The American university model has been investigated in a vast amount of studies. Ben-David's comparison originates in the 1960s, in our period (Ben-David, 1971, pp. 139–168). His work relies largely on Lawrence Veysey (1965).

society, was instrumental in both periods although the loyalty, morality, and culture had radically different contents in the respective societies.

Hungarian politicians had no intention of implementing university reform in the periods discussed here. In the nineteenth century modernization was closely tied to constructing an ethnically based Hungarian nation, whereas restructuring the university did not appear among the priorities of mid-nineteenthcentury politics. University reform was ordered by the Habsburg emperor. The Austrians, on the other hand, had not much concern about the actual status of scientific disciplines or the market of experts in the Hungarian part of the empire. These aspects apparently did not occur to the authorities while reshaping the universities.

By the mid-twentieth century the success of the American model became visible all over the world, or, in Wittrock's terminology, the 'third great transformation' in the university models came about. The market governs these models, which is influenced by the financial, industrial and business sectors (Wittrock 1993). Accepting that in the second part of the twentieth century the American model proved to be more successful in many academic fields than the German or Soviet models, we might conclude that it was in Hungary's interest to reshape its university according to this new pattern. However, given the needs of a country like Hungary after the Second World War, which was moving slowly on the road to modernization but was faced with the enormous task of reconstructing its life after the havoc of the war, the Soviet model might have had some advantages. Disregarding the political repression and the forceful ideological influence, the dictatorial methods and threatening atmosphere, the Socialist factory-like university was functional as it satisfied the then demand in Hungary.

The big changes in university models were unrelated to any kind of change in the knowledge they were supposed to transmit. Neither was the changes connected to specific practical requirements arising in the sphere of industrial or social technology. Both in the mid-nineteenth and mid-twentieth centuries, foreign military and political powers forced the universities to be reorganized because these powers intended to serve the interest of their empire. The puzzling result in both cases was, however, that they trained quite good experts.

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References

Austria Ministerium für Cultus und Unterricht. 1849. *Entwurf der Organisation der Gymnasien und Realschulen in Oesterreich*. Wien: K. K. Hof-und Staatsdruckerei.

Ben-David, Joseph. 1971. *Scientists' roles in society*. Englewood Cliffs: Prentice Hall.

Ben-David, Joseph. 1977. *Centers of learning: Britain, France, Germany, United States*. New York: McGraw-Hill.

Benedek, Pál. 1999. Polinszky Károly r. tag emlékezete. (Memory Károly Polinszky). In *Emlékbeszédek az MTA elhunyt tagjai felett 1998*. (Obituaries of members of the Hungarian Academy

of Sciences), ed. Ferenc Glatz. Budapest: Magyar Tudományos Akadémia. http://www.kfki.hu/chemonet/osztaly/emlek/polinszky.html. Accessed 5 Oct 2012.
Biró, Judit. 1990. *Magántanárok a pesti tudományegyetemen*. (Privatdozents at the University of Pest.) Budapest: Eötvös Loránd Tudományegyetem. Budapest: ELTE Eötvös Kiadó.
Evans, Robert J. W. 2006. *Austria, Hungary and the Habsburgs*: *Essays on Central Europe c. 1683–1867*. Oxford: Oxford University Press.
Fodor, Ferenc. 1955. *Az Institutum Geometricu: Az Egyetem Bolcsészeti Karán, 1782-tól 1850-ig fennállott mérnöki intézet*. (Institutum Geometricum at the Faculty of Philosophy.) Budapesti Müszaki Egyetem Központi Könyvtára Muszaki tudománytörteneti kiadványok, 5. Budapest: Tankönyvkiadó.
Graham, Loren. 1972. *Science and philosophy in the Soviet Union*. New York: Konopf.
Graham, Loren. 1994. *Science in Russia and the Soviet Union: A short history*. *Cambridge studies in the history of science*. Cambridge: Cambridge University Press.
Héberger, Károly, ed. 1979. *A Müegyetem története 1782–1967*. *The history of Technical University*. Vol. 1–8, 7. Budapest: Mimeographed text.
Huszár, Tibor. 1995. *A hatalom rejtett dimenziói*: *A Magyar Tudományos Tanács 1948–1949. The dimensions of power: Hungarian Council of Science*. Budapest: Akadémiai Kiadó.
Jarausch, Konrad. 1990. The German professions in history and theory. In *German Professions, 1800–1950,* eds. Geoffrey Cocks and Konrad Jarausch, 9–24. New York: Oxford University Press.
Johnson, Jeffrey. 1990. Academic, proletarian, … professional? shaping professionalization for German industrial chemists, 1887–1920. In *German Professions, 1800–1950,* eds. Geoffrey Cocks and Konrad H Jarausch, 123–142. New York: Oxford University Press.
Kenyeres, Ágnes, ed. 1994. *Magyar Életrajzi Lexikon 1978–1991* (Biographical Lexicon). Budapest: Akadémiai Kiadó.
Kollega Tarsoly, István, ed. 1996–2000. *Magyarország a XX. században* (Hungary in the 20th century) Szekszárd: Babits Kiadó. http://mek.niif.hu/02100/02185/html/74.html. Accessed 25 Sept 2012.
Kontler, Laszlo. 2002. *A history of hungary: Millennium in Central Europe*. Hampshire: Palgrave Macmillan.
Kónya, Sándor. 1975. *Az Akadémia ujjáalakulása és måködése 1957-ig*. (The Reorganization and Work of the Academy till 1977.) In *A Magyar Tudományos Akadémia másfél évszázada, 1825–1975* (One and a Half Centuries of the Hungarian Academy of Sciences), ed. Pál Zs Pach, 361–392. Budapest: Akadémiai Kiadó.
Kónya, Sándor. 1998. *A Magyar Tudományos Tanács (1948–1949). Hungarian Council of Science*. Budapest: MTA Könyvtár.
Ladányi, Andor. 1986. *Fels oktatási politika, 1949–1958 (Higher education policy), 22*. Budapest: Kossuth Kiadó.
Palló, Gábor. 1993. Internationalism in Soviet World-science: The Hungarian case. In *Denationalizing science: The contexts of international scientific practice,* eds. Elisabeth Crawford, Terry Shinn, and Sverker Sörlin, 209–232. Dordrecht: Kluwer Academic Publishers.
Palló, Gábor. 2000. Roles and goals of chemical textbooks on the periphery: The Hungarian case. In *Communicating chemistry: Textbooks and their audiences, 1789–1939,* eds. Bernadette Bensaude-Vincent and Anders Lundgren, 367–396. Science History Publications/USA. Canton: A Division of Watson Publishing International.
Pető, Iván, and Sándor Szakács. 1985. *A hazai gazdaság négy évtizedének története, 1945–1985 (The history of the four decades of the home economy),* 154–155. Budapest: Közgazdasági és Jogi Könyvkiadó.
Pünkösti, Árpád. 1992. *Rákosi a hatalomért*. Rákosi for Power. Budapest: Európa Kiadó.
Rácz, Kálmán. 2010. Az egyetemi autonómia Magyarországon 1848 és 1945 között. (Autonomy of University in Hungary 1848–1945). *Múltunk* 1:62–82.
Rákosi, Mátyás. 1951. Beszéd a magyar kormányküldöttség tiszteletére rendezett nagygyülésen 1949 június 23-án Prágában. (Rákosi's speech in Prague, 1949.) In Rákosi, *A békéért és* a szo-

cializmus építéséért. Beszédek. For peace and building socialism. Speeches. Budapest: Szikra. http://mek.oszk.hu/04300/04351/04351.htm. Accessed 28 Sept 2012.
Ridder-Symoens, Hilde de, eds. 1992–1996. *A History of the University in Europe*. Vol. I–II. New York: Cambridge University Press.
Ringer, Fritz K. 1969. *The decline of the German Mandarins: The German Academic Community, 1890–1933*. Cambridge: Harvard University Press.
Romsics, Ignác. 1999. *Hungary in the Twentieth Century*. Budapest: Corvina.
Rothblatt, Sheldon, and Björn Wittrock. 1993. Introduction: Universities and 'Higher Education'. In *The European and American university since 1800. Historical and sociological essays,* eds. Sheldon Rothblatt and Björn Wittrock, 1–18. Cambridge: University Press.
Rüegg, Walter, ed. 2004–2011. A history of the University in Europe. Vol. III. Universities in the nineteenth and early twentieth centuries. Vol. IV. Universities since 1945. Cambridge: Cambridge University Press.
Sashegyi, Oszkár. 2003. Az egyetem az önkényuralom korában 1849–1867. The university in the period of absolutism. In Az Eötvös Loránd Tudományegyetem története. 1635–2002. History of the Eötvös Loránd University, ed. László Szögi, 165–202. Budapest: ELTE Eötvös Kiadó.
Sugar, Peter, Frank, Tibor, and Peter, Hanak. 1994. *A History of Hungary*. Bloomington: Indiana University Press.
Szabadváry, Ferenc. 1982. *A* Budapesti Müszaki Egyetem *200 éve, 1782–1982* (200 years of the Technical University of Budapest). Budapest: Periodica Politechnica.
Szögi, László. 2001. *Az évszázados universitas* (The century old university). Budapest: Professzorok Háza.
Szögi, László, ed. 2003. *Az Eötvös Loránd Tudományegyetem története 1635–2002* (The history of Eötvös Loránd University). Budapest: ELTE Eötvös Kiadó.
Veysey, Lawrence. 1965. *The Emergence of the American University*. Chicago: Chicago University Press.
Wittrock, Bjorn. 1993. The modern university: the three transformations. In *The European and American university since 1800: Historical and sociological essays,* eds. Sheldon Rothblatt and Björn Wittrock, 303–362. Cambridge: University Press.

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Chapter 9
The Autonomous Industrial University of Barcelona (1933–1934?) and the Frustrated Expectations of Democracy in Pre-war Spain

Antoni Roca-Rosell

Technical industrial education was formalized in Spain after 1850 with the creation of a system of courses ranging from elementary vocational education to higher engineering. The plans of the Spanish government partially failed, and in 1867 all the schools except the one in Barcelona were closed. This school provided courses for advanced industrial engineers whereas other levels of technicians were to be trained at workshops or factories. In subsequent decades, some municipalities and private institutions, including religious orders, promoted vocational schools. The idea of 'industrial schools', centres at which all levels of engineering could be taught, emerged as an alternative to this situation. In 1901, the Spanish government created several of these schools, and the Industrial School or Industrial University of Barcelona was created in 1904. It was the ambition of this centre to establish a great technological 'campus' at the service of the Catalan economy.

This paper focuses on a unique document regarding the autonomy of the Industrial University of Barcelona dated in 1933 or 1934. The document, Ponencia sobre un Estatuto de la Universidad Industrial de Barcelona (1933–1934), was found unexpectedly by Guillermo Lusa and myself some years ago.The project to give autonomy to centres of technical education should have been included in the efforts to modernize higher education in Spain but it should be mentioned that the Spanish universities had been centralized and had lost their capacity to develop research. Autonomy for the Spanish universities was a means of renovation. The fact that technical education was included in the movement towards autonomy is highly significant. In addition, the proposal for an Industrial University of Barcelona has some peculiarities and reveals a particular conception of technical education.

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9.1 Autonomy as the Panacea for University Renewal in Spain

One of the main features of universities was their autonomy or self-government. By 1900, there were several university systems in the world. In England, the governance of the older universities (Oxford and Cambridge) came from medieval times and the autonomy of colleges and faculties played a central role. A number of other universities developed in Britain during the nineteenth century, with different pattern of governance (Cardwell 1972). In Germany, the universities developed during the nineteenth century under the patronage of cities, regional states (Der Lander) or imperial administration. In France, the State took charge the education system, including the universities, by means of a centralized control that gave opportunities to each faculty. Harry Paul (1985) considers that criticism about lack of resources expressed by French teachers was more a rhetorical strategy than a reality. Generally speaking, we may conclude that universities enjoyed a significant autonomy both economically and academically; they were able to manage their own funds as well as organising teaching and research.[1] In 1930, Abraham Flexner published an essay on how modern universities should be constituted and managed. His point of view was critical as regards American universities, and most in favour of those in Germany.[2] A few years later, Flexner promoted the Institute for Advanced Studies at Princeton (Flexner 1930). In his arguments, Flexner addressed the role of research in universities, and their connection with society, etc., whereas the question of autonomy was not a matter of discussion.[3]

In Spain, after 1833, successive liberal governments undertook a complete reform of the universities. According to Peset and Peset (1974), one significant reform was the dissolution of separate resources for the universities, some of them dating from medieval times, and the inclusion of these resources in the general State budget. While this paved the way to economic viability for the state university system, it also exerted a strong political control on each university. With Pidal's Law in 1845, the Minister of the Fomento (the ministry gathering many fields, including public works, economy and education) became the authority directly responsible for the universities (Peset and Peset 1974, Chap. 17).

The idea of autonomy was launched in the early twentieth century as a way to modernize the universities. Many meetings of university teachers concluded that the teachers' faculty should have decision-making powers in university matters: preparation of syllabuses and contracts for new teachers were the main issues. At that time, the central state government in Madrid had exclusive responsibility for

[1] At present, autonomy is one of the main issues concerning university reform in Europe, see Parliamentary Assembly (2006). See also Charle (2004) and Gerbod (2004).

[2] The self-government of the German universities has been a central issue in the higher education system of this country. For the actuality of the question after the Second World War, see, for example, Hahn (1964).

[3] For a world overview, see Brock (1990).

these and other questions. The universities were obliged to accept their status simply as departments of state administration.

In Catalonia, the idea of autonomy was particularly attractive to the university community. The University of Barcelona had been dismantled after the War of Spanish Succession (1700–1714). Although it was restored in 1837, the central organization of universities ruled, for example, that the Central University of Madrid was the only body authorized to confer doctorates. This formed part of Moyano's Law (1857), which laid down the guidelines for the general system of education.[4] The result was that universities outside Madrid became subordinated centres, unable to promote higher-educational courses (Peset and Peset 1974, Chap. 27).

In 1900, many sectors in Spain were convinced of the need for a comprehensive reform of education, including at university level. The creation of a ministry exclusively for education raised many hopes, but the limits of its action were soon to appear. In 1900, a new organization for the faculties of Science was set up, and in 1901 a new plan for technical education. In both cases, the State recognized its inability to carry out in-depth reforms. Also necessary to take into account is the economic and social context of Spain in 1900, which involved a process of modernization entailing a slow process of industrialization.[5]

In several Spanish universities, autonomy was thought to be the way to put the universities at the service of the society. The process in Barcelona is particularly interesting. Some undergraduate student associations came together in 1903 in what they called the *Primer Congrés Universitari Català* (First Catalan University Congress), which included a few teachers from the University of Barcelona (Puig i Reixach ed. 1977). One of the aims of the Congress was to establish a plan for a Catalan University with full autonomy, i.e., the right to manage its own affairs without interference. The authorities initially vetoed the congress, but finally it was held in the Ateneu Català, outside the University building.

The Second Catalan University Congress took place in 1918.Taking advantage of a restriction of rights due to popular unrest, the authorities again tried to forbid the sessions. Nevertheless, the Congress was held in April in the main hall of the University, most of the participants being undergraduate students, although this time more professors attended the meeting. A detailed plan for an autonomous university was approved, including the right to set the syllabus for the different degree courses, the hiring of teachers, and in general the management of State funds provided for the University of Barcelona. As a result of the Congress, a project of Statutes was approved.

Students from the School of Industrial Engineering participated in both congresses, incorporating a new orientation for their centre, which was considered as part of the University. It should be remembered that the School of Industrial Engineering, like other technical schools, was not formally regarded as a University.

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[4] Moyano's Law governed Spanish education for more than a century. See Peset and Peset 1974, Chap. 18.

[5] See, for example, Ringrose (1996). Also Nadal Oller ed. 1988–1994.

The idea of autonomy for universities was not exclusively a Catalan demand; many students and teachers belonging to Spanish universities also shared it. It was therefore no surprise that in May 1919 the new Minister for State Education, César Silió, approved a Royal Decree giving autonomy to all Spanish universities (De Puelles Benítez 1986, pp. 267–269). In 1922, however, after a national debate in which many sectors protested against Silió's decision, the Decree was withdrawn. The 'autonomists' considered that the Decree had not been discussed in the university faculties, and therefore did not reflect the real needs of the university community. Others objected that a Decree in itself was insufficient to countermand a higher ruling such as Moyano's Law. Finally, the reluctant sectors considered that the universities were not prepared for autonomy. In accordance with the Decree, some universities (Seville, Valencia, Valladolid, Murcia, Granada, Salamanca, Barcelona, and Madrid) approved their own statutes, i.e., rules for the management of each centre (Pozo Ruiz 2008).

From a formal point of view, the Silió Decree seemed an important step towards the renewal of Spanish universities. Nevertheless, the State failed to approve the distribution of funds needed for university autonomy. Without funds and without a real legal base, Silió's project was condemned to failure.

In September 1923, a military coup led to government by dictatorship and the plans for university reform were abandoned. In fact, the new regime sought to increase its control over the universities, which were focal points of calls for democratic rights.

After the end of the Dictatorship and the proclamation of the Republic in 1931, the question came to the forefront again. Many progressive groups of university teachers took advantage of the new regime to introduce autonomy for universities, at least as regards the election of the University governing bodies and the supervision of these institutions. A law granting autonomy to the universities of Madrid and Barcelona was approved in 1933. The University of Barcelona, renamed the Autonomous University of Barcelona, drew up its own statutes, in which many of the historical demands were satisfied: a democratic government, the right to approve the syllabus, the right to contract teachers, etc. The concession of autonomy was limited to the universities of Madrid and Barcelona in order to avoid the opposition existing in the other universities. In the case of Barcelona, autonomy went hand in hand with the process of political autonomy. In 1932–1933, the Catalans achieved their own regional government, including a Parliament, in order to open a process of self-determination within the Spanish Republic, which would in fact become a kind of federal state.[6]

The existence of the Autonomous University of Barcelona was short-lived, because the right-wing Republican government of 1934 suspended its Statutes. However, they were reintroduced after the victory of the Popular Front in February 1936. This took place only a few months before the outbreak of the Civil War in July

[6] Political autonomy was forecast for the other historical regions, Galicia and the Basque Country. Nevertheless, these regions were not able to constitute their own government before the outbreak of the Spanish Civil War. See for example, Termes (1987), Carr (2000).

1936. Despite the brevity of its legal existence, the experience of the Autonomous University of Barcelona was highly significant and became an example of a modern, dynamic university in Spain (Ribas i Massana 1976). The Statutes of the Autonomous University were fully applied in the Faculty of Philosophy and Letters, and in the Faculty of Medicine. Other faculties, such as Law, Pharmacy, and Sciences, however, lagged behind in the application of the new regulations.

9.2 Technical Education in Barcelona. The Industrial University

Technical education in Spain underwent considerable transformation at the beginning of the twentieth century (Roca-Rosell ed. 2008, Chap. 1). The loss of the Spanish colonies overseas (Cuba, the Philippines, and Puerto Rico) in 1898 triggered a debate about the situation of science and technology in the country. The victory of the United States over Spain—in the war that led to the independence of Cuba and the Philippines—was attributed to the superiority of its laboratories and research centres (Roca-Rosell and Lusa 1998). In an attempt to reform education in the country, the Spanish government created the Ministry of Public Instruction in 1900. It was the first time that Spain had had a separate department for education. The new Ministry asked the Fomento del Trabajo Nacional, a Catalan association of entrepreneurs, to prepare a report on vocational training and the needs of Spanish industry. A few months later, the Fomento presented the report, which was published in its bulletin and in other technical journals (Proyecto de Escuelas Industriales 1900).

The report proposed a reform of technical education in Spain in order to assist industrial development. It included the need to modernise agriculture by the introduction of new machines, new chemical products, and new procedures, i.e. the industrialization of agriculture, given that industry was identified with progress and welfare. The Fomento agreed with the Ministry to promote what they called "Industrial Schools" throughout the country. A number of options were examined: the systems in France and Belgium; Switzerland and Germany; England; and finally the United States.[7] The American model was the one proposed by the Fomento, and this last option merited the most extensive analysis in the report. As a consequence, it was established that scientific and practical training were to be combined in the new industrial schools.

[7] It should be remembered that technical education was in very different situation around the world. In France, the "Grandes Écoles" had enormous prestige without relationship to the universities. In Germany, the technical high engineering schools became university centres in the 1870s including technical research. In countries such as Belgium or Switzerland technical education followed the French and German system. In Great Britain, technical education had difficulties to be recognised. In the United States, technical education was in a process of transformation from pure vocational centres to university centres. For an international comparison, see Kranzberg (1986). For an overview on technical education, see Guaginini (2004).

Following the report by the Fomento, a decree on public instruction was approved in 1901, which included plans for reforming technical education. Although nine industrial schools were created, the foundation of the Barcelona school was postponed. The promoters of this centre were more ambitious and preferred to bide their time and wait for a more opportune moment. The year 1904 seemed to be more propitius, and after a decree by the Spanish government that led to the Industrial School of Barcelona, its Board of Patrons was established (Escuela Industrial 1904). Among the institutions making up the Board were the Fomento, the Association of Industrial Engineers, the Catalan Board of Commerce, the Municipality of Barcelona and the Diputació Provincial of Barcelona. The Higher School of Industrial Engineers also formed part of the Board of Patrons, since it would be housed in the new Industrial School. The Board bought an old factory—ca'n Batlló, designed by the architect Rafael Guastavino (Rosell 1995, 2002)—where the different centres would be located. However, work on the school did not start until 1909 because of insufficient funds. By 1907 the situation had improved thanks to the formation of a new Catalan Nationalist government in the Diputació, presided over by Enric Prat de la Riba, who considered technical education to be a priority (Roca-Rosell and Salavert Fabian 2009).

In 1908 King Alfonso XIII visited the Industrial School in order to learn about the projects. The industrial engineer August de Rull, secretary of the Board of Patrons, set out the main points of the ambitious plan, stressing the size of ca'n Batlló for the location of the technological centres:

> The extent of the project of the Board of Patrons can be judged by the size of the property purchased, where we have the great honour to receive your Royal majesty. [This building] seems to highlight the practical orientation of our project, since these premises, which were once a factory, were closed down because of labour problems, but are reopened today with the aim of contributing to a peaceful artistic and industrial Spain. (Visita 1908: n/p)

The first centre to be opened in the new building was the Textile School. This was a practical centre dating from 1849. The new facilities in 1909 included a real life model of a textile factory with machines bought in England, which enabled students to learn under real factory conditions; the courses included theory classes, i.e., elementary mathematics, physics, and chemistry. Some other centres and laboratories were subsequently added, one of the most important being the Escola del Treball, a centre for elementary technical education. This was the continuation of the Escuela de Artes y Oficios, set up in 1868 by the School of Industrial Engineers, but completely revamped. The School was endowed with expensive facilities, including electric lighting for evening classes. It was designed to train young workers for specialization in engineering work, such as mechanics, machinery, automobiles, electricity, or masonry.[8] The project of the Industrial School would culminate in the incorporation of the Higher School of Industrial Engineers. However, because of serious disagreements between the faculty of the Engineers School and the board of the Industrial School, this did not take place until 1927. Meanwhile, in 1917 a centre for electrical and mechanical engineering, the Institut d'Electricitat Aplicada,

[8] On technical education in Barcelona, see Alberdi (1980).

was created, which housed laboratory facilities. In 1919 the Laboratori General d'Assaigs (General Testing Laboratory) was set up to coordinate the existing laboratories of the Industrial School: textiles, chemistry, agriculture, tanning, bleaching, electricity, and mechanics (Roca-Rosell et al. 2006). In 1922 the Spanish government declared this laboratory to be "official", i.e. the laboratory was able to issue certificates on the quality of products and the resistance of materials. This laboratory complemented industrial laboratories, in what might be regarded as the consolidation of an engineering laboratory *culture* (Roca-Rosell 1996).

All these centres—schools and laboratories—were called the "Industrial University" of Barcelona, based on the applied sciences and engineering, as a complementary institution of the "Literacy" University.[9] However, except for the School of Industrial Engineers, none of the schools of this Industrial University were authorized to award university degrees. The use of the word "University" refers to the universal ambition of the centre, and not to an administrative function.[10] In addition, the Industrial University of Barcelona had created non-official degrees on technical and vocational education.

Another adjective was also used, the "Universitat Nova" (New University), probably because Technology and Engineering, being new and modern, were regarded as the main basis of the new universities. The Catalanist movement defined itself as new and modern, and was closely linked to science and technology (Roca-Rosell and Salavert-Fabiani 2009). Notice that this institution formed part of the development of a civil discourse of science in Spain (Roca-Rosell 2007).

In September 1923 a military coup ushered in the dictatorship of General Primo de Rivera. One of the aims of the new regime was to change the orientation of the Industrial School of Barcelona. In 1924 more than 100 teachers and employees were sacked. The non-official degrees in Engineering awarded by the Industrial School were replaced in 1929 by the official degree, the *perito*, i.e., for a medium-level engineer. In 1927 the transfer of the School of Industrial Engineers to the Industrial School was completed. King Alfonso XIII and the dictator Primo de Rivera presided over the celebrations. Henceforth, the Industrial School offered technical education at all levels, from apprenticeships to higher engineering. Thus, it could be said that the Industrial School of Barcelona project was accomplished, although its original goal, to embrace social, democratic, and Catalan ideals, had been abandoned.

Technical education was overhauled during the dictatorship of Primo de Rivera. This was the result of two decrees, one in 1924 and the other in 1928. It is indeed ironic that the Industrial School of Barcelona was used as the model for technical education in Spain at a time when this school was subjected to severe political repression. The end of the Dictatorship in 1930 and the proclamation of the Republic in April 1931 changed the situation of the Industrial School of Barcelona. Staff

[9] In Spanish, Universidad Literaria, composed of the faculties of Law, Letters, Pharmacy, Medicine, and Sciences.

[10] Flexner (1930) expressed a great criticism to the American universities for including high schools.

who had been expelled in 1924 were readmitted and the former technical graduations were recognised, although the general regulations of 1924 and 1928 were not modified. For some authors, such as Galí (1981, pp. 45–46), this demonstrates the lack of interest by Republican leaders in technical education. This opinion is really relevant because Galí was personally involved in the Industrial University, suffered under the repression of the Primo de Rivera regime, and eventually rejoined the centre in 1930.

9.3 The Statutes of the Autonomous Industrial University

The process of autonomy at the University of Barcelona created many hopes in the Catalan engineering world, although after the reforms of 1924 and 1928, technical education had been separated from general education and for this reason played no part in the process of autonomy. In 1933, the journal of the Association of Industrial Engineers of Barcelona, *Tècnica*, published an editorial note calling for the inclusion of the Barcelona School of Industrial Engineers within the University of Barcelona, benefiting from the process of modernisation approved that year (L'Escola d'Enginyers 1933). Moreover, in October 1933 the young industrial engineer J. Torrens-Ibern stated that autonomy was needed in order to reform the industrial engineering syllabus, to incorporate distinguished engineers as teachers, and to create an institute for electrotechnics as well as an institute for industrial management (Torrens-Ibern 1933). Torrens-Ibern made no mention of any project of autonomy for the Industrial University (Roca-Rosell 2009).

No further news about this subject was published until Guillermo Lusa and the author of this paper found by accident a draft of the Statutes for an Autonomous Industrial University of Barcelona.[11] Despite the perception of authors such as Galí, the document demonstrates that during the II Spanish Republic (1931–1939) engineering continued to play an important role.

Let us consider some details of the Statutes. First of all, while there is no mention of a date, we are able to affirm that this document was drawn up in 1933–1934. In the Industrial University Statutes there is a reference to the Statutes of the University of Barcelona, approved in 1933. In October of that year, Torrens-Ibern argued on autonomy, but without mentioning any project for the Industrial University. In addition, in October 1934 there was a revolutionary movement against the conservative government of the Republic, one of the results of which was the suspension of the autonomy of the University of Barcelona. The Statutes of the Industrial University must therefore have been written between these two dates (Lusa 2006).

No mention is made of the authorship of the document, and we have been unable to find any reference to it in any other source. Nevertheless, we may assume that a commission drew it up, since this was the common practice at the time. This

[11] Ponencia. 1933–1934. The text was found in the Photographic Archive of the City of Barcelona in 2000. A set of pictures of the Industrial University was "protected" with the document.

hypothetical commission would have consisted of some of the people who were discussing the renewal of technical education. We believe that reformers such as the industrial engineers Rafael Campalans (1887–1933); [12] Estanislau Ruiz Ponsetí (1889–1967) (Ferré i Trill 1993) and Joaquim Torrens-Ibern (1909–1975),[13] as well as the pedagogue Alexandre Galí (1886–1969),[14] may well have been involved in the project. In the case of Galí, who wrote an impressive history of education in Catalonia during the first third of the twentieth century, a posthumous publication, there is no mention of the project, perhaps because it was only a project.

9.3.1 The Text

The available text is incomplete, and finishes abruptly on page 11. The document is divided into 10 "titles" or parts, which follow closely the structure of the University of Barcelona Statutes (Universitat de Barcelona 1934, pp. 33–49). This leads us to suppose that the unavailable parts are those dealing with "Students", "The professional, graduate and alumni associations", and the "Complementary articles."

The first 'title' begins with an article setting out the Industrial University as a legal entity. After this, the following article states that "The Industrial University is autonomous in the learning and administrative orders, in the recognised form of the current regulations governing the University of Barcelona."

Afterwards, there is a declaration regarding Spanish and Catalan as the official languages of the University, the use of which should be based on respect for general freedom of expression.

The second part is devoted to the "Possessions[15] of the Industrial University". There is a reference to the facilities in the buildings occupied at that time and all their contents. The income of the Industrial University would come from tuition fees, revenue arising from the property of the University, subsidies from the Spanish State and the Catalan Government (Generalitat), and donations from private or public entities. This possibility of receiving income from private sources was a really new development in Spain.

The third part states that the Industrial University would be governed by a Board of Patrons composed of five members designated by the Spanish Republic and five by the Generalitat. The rector of the University would form part of the Board, but could not hold the positions of president, vice-president or secretary. The functions of the Board of Patrons were as follows: to prepare and modify the Statutes of the University, to supervise the different centres of the University, to approve the internal Rules ("reglamentos") of each centre, to appoint University staff according

[12] See Campalans (1973), Riera Tuèbols (1990).

[13] On Torrens-Ibern and his commitment to technical education see Lusa (2006, pp. 103–106).

[14] Alexandre Galí has been a relevant reformer of education in Catalonia. A summary of his trajectory, reproducing some of his texts, is in Galí i Herrera (1995).

[15] In Spanish: "Patrimonio".

to the Statutes, to manage the economic resources, and approve the University's annual budget.

There is a specific section devoted to the Rector, in which we find several differences from the Statutes of the University of Barcelona. The Rector of the Industrial University would be named by the Generalitat and could not be a teacher at the Industrial University. The Rector was the general supervisor of the University. He was obliged to be present every day on University premises during teaching hours and he was to live in the University Residence. Notice that unlike the Literacy University, the Rector was not the representative of the university community. This peculiarity may be explained by the fact that until then there would have been no rector at the Industrial University.

The fifth part contains the regulations of the "Junta Universitaria", a board composed of the Rector, the supervisor and two teachers from each school, one workshop master (Maestro de taller, a technical assistant) and one student. This Junta was charged with setting the syllabuses of the schools, according to their proposals. The Junta also had disciplinary authority.

The sixth part is devoted to the "Claustro general", which means the entire faculty of the Industrial University: the Rector, all the teachers, workshop and laboratory masters, and the students belonging to the faculties of their schools.

The seventh part deals with the schools themselves. First of all, there is a list of the seven centres (or groups of centres) of the Industrial University: (a) the School of Industrial Engineers (b) the school of specialist engineers ("ingenieros especialistas"); (c) the schools of "directors of industries" and workshop masters; (d) the School of Labour ("Escuela del Trabajo"); (e) the School of pre-Apprenticeship ("preaprendizaje"); f) the Psychotechnological Institute ("Instituto Psicotécnico"); (g) the School of Commerce. In fact, the only centre of higher education to be recognised at a university level would be the School of Industrial Engineers. The Psychotechnological Institute was a centre for applied psychology with high-level research.[16] The other centres were vocational training schools. It should be remembered that the Industrial University had been conceived as a comprehensive centre for technical training, from apprenticeships to the higher engineering. The composition established in the Statutes results from this conception.

The eighth part deals with the teachers of the Industrial University. Five types of teachers are considered: (a) "profesores numerarios o catedráticos" (full professors) (b) "profesores de prácticas" (teachers of practical classes) (c) "profesores repetidores" (assistants) (d) "profesores honorarios" (honorary teachers) (e) "maestros de taller" (workshop masters). Given that the University was responsible for paying its teachers, their status is defined in great detail. As regards the full professors, it is stated that their number will be limited. Nevertheless, some of these professors had already been appointed by the State, although the Board of Patrons had the right to appoint other professors according to requirements and financial resources. As regards other types of teachers, the main novelty was the honorary teachers, persons

[16] One of the promoters of this centre was Emili Mira López, who went to exile after the Spanish Civil War. See, for example, Mülberger (2010).

with suitable background and qualifications. In view of its autonomous status, all the teachers would be selected and contracted by the Industrial University. This was a significantly new development, since until then all teachers of official institutions had been appointed through the central state in Madrid. The Industrial School depended on the Barcelona Diputación and some of its teachers were appointed through this body.

The ninth part deals with the organization of the syllabuses. According to the project, each school of the Industrial University would prepare its own syllabus, its conditions for admission, and the corresponding schedule for graduation. The Board of Patrons was to approve these proposals. This was also a new development, such matters normally being determined by the central Spanish administration.

Some paragraphs in the tenth part (those available in our copy) are devoted to the "Claustro extraordinario" (extraordinary general assembly). This Claustro was composed of all the teachers, union representatives (those unions connected with the subjects of the Industrial University), and one student representative.

Despite the many differences in subjects and the level of the centres belonging to the Autonomous Industrial University, the Statutes were aimed at providing them with a high degree of coordination, ensuring quality education for good engineers in different specialities and offering facilities for testing and research. Until then, a Board of Patrons had been in charge of the management of the Industrial University, without formal connections with the schools and laboratories. The new Statutes adopted for University organization would provide greater academic consistency. Each school would be able to manage its own teaching and research activities in collaboration with representative members from the other centres belonging to the Industrial University, and without "external" interference. It was thanks to this new organizational structure that the original objectives of educating engineers in theoretical and practical skills could be achieved. In this sense, the Statutes constituted further progress in the process initiated in 1904.

We do not know why the project of autonomy for the Industrial University was never carried out. The political instability of the Republican Government before the coup of July 1936 that triggered the Spanish Civil War may provide an explanation, as well as accounting for why the project was forgotten.

9.4 Final Remarks

The Statutes of 1933–1934 would have provided a solid basis for a new organization of the Industrial University of Barcelona. The idea of an Industrial University took shape in the first decades of the twentieth century. The centre was officially inaugurated in 1908 and was ardently supported by the policy of the Catalan Nationalist parties (with the agreement of both the workers and entrepreneur unions). The close relationship between Catalan Nationalism and the Industrial University was certainly the main reason for the repression that followed after Primo de Rivera's coup in 1923. In 1924–1928, the dictatorship created new regulations for Technical

Education, according to which Technical Education was definitively separated from the University.

The call for autonomy was a central issue in Spanish universities at the beginning of the twentieth century. Spanish teachers realized that self-government was crucial for the universities and tried to introduce a new system in Spain. Some attempts were made before the establishment of autonomous universities in Barcelona and Madrid in 1933, after the proclamation of the II Republic (1931). Although the experience was short-lived (it was halted by the Spanish Civil War, 1936–1939), it raised many hopes. This situation was reflected in the attempt to extend autonomy to technical education, despite the fact that it did not belong to the University. This project was completely unknown until a text consisting of a scheme for statutes for the Industrial University of Barcelona was found some years ago. Although the project was never implemented, it shows that the world of technical education was aware of the need for the self-government of teaching and research centres. The Industrial University of Barcelona encompassed a variety of centres ranging from vocational to higher engineering education. Its autonomous status would signify the definitive recognition of technical education in the democratic Spain of the 1930s. The Industrial School of Barcelona sought to become a 'complete' technical centre with teaching at all the levels from apprenticeships to higher engineering, and with laboratories for testing and technical research. Since industry and manufacturing were two of the mainstays of modern Catalonia, the project was closely linked to the call for recognition of the overall Catalan reality, and an Industrial University with full autonomy would have been a further step forward in this project.

References

Alberdi, Ramon. 1980. *La formación profesional en Barcelona. Política – Pensamiento – Instituciones 1875–1923*. Barcelona: Don Bosco.

Brock, W. H. 1990. Science education. In *Companion to the history of modern science,* eds. R. C. Olby, G. N. Cantor, J. R. R. Christie, and M. J. S. Hodge, 946–959. London: Routledge.

Campalans, Rafael. 1973. *Ideari de Rafael Campalans,* ed. Albert Balcells. Barcelona: Pòrtic.

Cardwell, Donald S. L. 1972. *The organization of science in England*. London: Heinemann Educational.

Carr, Raymond, ed. 2000. Spain: A history. Oxford: Oxford University Press.

Charle, Christophe. 2004. Patterns. In *A history of the university in Europe. Volume III. Universities in the nineteenth and early twentieth centuries (1800–1945),* ed. Walter Rüegg, 33–79. Cambridge: Cambridge University Press.

De Puelles Benítez, Manuel. 1986. *Educación e ideología en la España contemporánea*. Barcelona: Labor.

Escuela Industrial de Barcelona. Acta. 1904. Revista Tecnológico-Industrial, 27 (May), 109–129. Facsimile in Documentos de la Escuela de Ingenieros Industriales de Barcelona, num. 12, 2002, 108–128. http://upcommons.upc.edu/revistes/handle/2099/967. Accessed June 2013.

Ferré i Trill, Xavier. 1993. *Estanislau Ruiz i Ponsetí: sindicalisme i política*. Maó: Revista de Menorca.

Flexner, Abraham. 1930. *Universities. American, English, German*. New York: Oxford University Press.

Galí, Alexandre. 1981. *Història de les institucions i del moviment cultural a Catalunya 1900–1936. Llibre IV. Ensenyament tècnico-industrial i tècnico-manual o d'Arts i Oficis*. Barcelona: Fundació AG.

Galí i Herrera, Jordi. 1995. *Alexandre Galí i el seu temps*. Barcelona: Proa.

Gerbod, Paul. 2004. Resources and management. In *A history of the university in Europe. Volume III. Universities in the nineteenth and early twentieth centuries (1800–1945),* ed. Walter Rüegg, 101–121. Cambridge: Cambridge University Press.

Guagnini, Anna. 2004. Technology. In *A history of the university in Europe. Volume III. Universities in the nineteenth and early twentieth centuries (1800–1945),* ed. Walter Rüegg, 593–635. Cambridge: Cambridge University Press.

Hahn, Walter. 1964. Patterns and trends in West German universities: Academic self-government versus state control. *The Journal of Higher Education* 36 (5): 245–253.

Kranzberg, Melvin, ed. 1986. *Technological education-Technological style*. San Francisco: San Francisco Press.

L'Escola d'Enginyers de Barcelona dintre de la Universitat. 1933. *Tècnica* 46 (177): 349.

Lusa, Guillermo. 2006. La Escuela de Ingenieros de la Dictadura a la República (1927–1936), Documentos de la Escuela de Ingenieros Industriales de Barcelona, 16:3–119. http://upcommons.upc.edu/revistes/handle/2099/2261. Accessed June 2013.

Mülberger, Annette. 2010. Un psicólogo abandona su mundo: El exilio de Emilio Mira y López. In *El exilio científico republicano,* ed. J. L. Barona, 157–172. Valencia: PUV.

Nadal Oller, Jordi, ed. 1988–1994. *Història econòmica de la Catalunya contemporània*. Barcelona: Enciclopèdia Catalana.

Parliamentary Assembly. 2006. Recommendation 1762. Academic freedom and university autonomy. http://assembly.coe.int/Documents/AdoptedText/ta06/ERec1762.htm. Accessed June 2013.

Paul, Harry W. 1985. *From knowledge to power. The rise of the science-empire in France 1860–1939*. Cambridge: Cambridge University Press.

Peset, Mariano, and José Luis Peset. 1974. *La Universidad española, siglos XVIII y XIX: despotismo ilustrado y revolución liberal*. Madrid: Taurus.

Ponencia sobre un Estatuto de la Universidad Industrial de Barcelona. 1933–1934. CRHT archives, UPC. Facsímile version in Documentos de la Escuela de Ingenieros Industriales de Barcelona 16, 2006: 236–246 http://upcommons.upc.edu/revistes/handle/2099/2264. Accessed June 2013.

Pozo Ruiz, Alfonso. 2008. La autonomía universitaria en el Decreto de César Silió (1919), Alma Mater Hispalense. 500 años. http://personal.us.es/alporu/historia/plan_cesar_silio_1919.htm. Accessed June 2013.

Proyecto de Escuelas Industriales. 1900. El Trabajo Nacional, IX (July): 41–56. Reproduced in Documentos de la Escuela de Ingenieros Industriales de Barcelona, 12, 2002: 67–82. http://upcommons.upc.edu/revistes/handle/2099/967. Accessed June 2013.

Puig i Reixach, Miquel, ed. 1977. *Els Congressos Universitaris catalans. Catalanització i autonomia de la Universitat*. Barcelona: Undarius.

Ribas i Massana, Albert. 1976. *La Universitat Autònoma de Barcelona (1933–1939)*. Barcelona: Edicions 62.

Riera Tuèbols, Santiago. 1990. Rafael Campalans. In *Quatre enginyers industrials per a la història: Carles Pi i Sunyer, Pompeu Fabra i Poch, Rafael Campalans i Puig, i Josep Serrat i Bonastre*, 86–144. Barcelona: Associació i Col·legi d'Enginyers Industrials de Catalunya, La Llar del Llibre.

Ringrose, David R. 1996. *Spain, Europe, and the Spanish miracle*. Cambridge: Cambridge University Press.

Roca-Rosell, Antoni. 1996. L'enginyeria de laboratori, un repte del nou-cents. *Quaderns d'Història de l'Enginyeria* 1:197–240.

Roca-Rosell, Antoni. 2007. El discurso civil en torno a la ciencia y la técnica. In *El regeneracionismo en España,* eds. M. Suárez Cortina and V. L. Salavert Fabiani, 241–259. Valencia: Universitat de València.

Roca-Rosell, Antoni, ed. 2008. *L'Escola Industrial de Barcelona. Cent anys d'ensenyament tècnic i d'arquitectura*. Barcelona: Diputació de Barcelona, Ajuntament de Barcelona, and Consorci de l'Escola Industrial de Barcelona.

Roca-Rosell, Antoni. 2009. La formation des ingénieurs industriels catalans pendant la période républicaine (1931–1939). À la recherche d'une nouvelle conscience professionnelle?. In *Jogos de identidade profissional: os engenheiros entre a formação e a acção,* eds. A. Cardoso de Matos, M. P. Diogo, I. Gouzevitch, and A. Grelon, 501–512. Lisboa: Colibri.

Roca-Rosell, Antoni, and Guillermo Lusa. 1998. Un altre 98? Ciència i tècnica al voltant de 1900. *Afers* 31:609–626.

Roca-Rosell, Antoni, and Vicent L., Salavert Fabiani. 2009. Catalanisme, valencianisme i ciència en el canvi de segle. In *La Ciència en la història dels Països Catalans,* eds. R. Parés and J. Vernet, vol. 3, 523–569. Barcelona: Institut d'Estudis Catalans, Universitat de València.

Roca-Rosell, Antoni, Guillermo Lusa-Monforte, Francesc Barca-Salom, and Carles Puig-Pla. 2006. Industrial engineering in Spain in the first half of the twentieth century: From renewal to crisis. *History of Technology* 27:147–161.

Rosell, Jaume. 1995. Rafael Guastavino i Moreno: enginy en l'arquitectura del segle XIX. In *Ciència i tècnica als Països Catalans: una aproximació biogràfica,* eds. J. M. Camarasa and A. Roca-Rosell, 494–522. Barcelona: Fundació Catalana per a la Recerca.

Rosell, Jaume. 2002. Rafael Guastavino i Moreno: inventiveness in 19th century architecture. In *Guastavino Co. (1885–1962): Catalogue of works in Catalonia and America,* 44–59. Barcelona: Col·legi d'Arquitectes de Catalunya.

Termes, Josep. 1987. *De la revolució de setembre a la fi de la Guerra Civil: 1868–1939*. Barcelona: Edicions 62 (Història de Catalunya, vol. 6).

Torrens Ibern, Joaquim. 1933. Qüestions d'ensenyament tècnic, mss, 10 pp, October. Reproduced in Documentos de la Escuela de Ingenieros Industriales de Barcelona, vol. 16, 2006: 219–229. http://upcommons.upc.edu/revistes/handle/2099/2260. Accessed 1 Nov 2014.

Universitat de Barcelona. 1934. *Anuari 1934–1935*. Barcelona: Tip. Occitania.

Visita de S.M. el Rey D. Alfonso XIII a los terrenos y edificios donde ha de instalarse la Universidad Industrial de Barcelona. 1908. Barcelona: Imprenta Sucesor F. Sánchez. Reprint. Barcelona: EUETIB, 2004.

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Chapter 10
Reform and Repression: Manuel Lora-Tamayo and the Spanish University in the 1960s

Agustí Nieto-Galan

10.1 Introduction

In the 1940s, after the Spanish Civil War (1936–1939), many members of the so-called *generación de plata de la ciencia española* (Silver generation of Spanish science) suffered a severe interruption to their careers (Otero Carvajal et al. 2006, Otero Carvajal and López Sánchez 2012). Exile, internal repression and marginalization reduced the number of University professors by almost half in relation to the pre-war years (Giral 1989, p. 21).[1] Promising research schools with solid international reputations were closed and dismantled. Ideological control and autarky governed the scientific policies of the new regime for years. After the foundation in 1939 of the new National Research Council, the *Consejo Superior de Investigaciones Científicas* (CSIC), the new authorities publicly exhibited their obsession with erasing any trace of the scientific culture of the *Junta para la Ampliación de Estudios e Investigaciones Científicas* (JAE), the pre-war government body for the promotion of scientific research, which had led research policies from the beginning of the twentieth century (Sánchez Ron 1988, 1998, 1999; Otero Carvajal and López Sánchez 2012).

Historians have described in recent years how scientific and academic knowledge in general was destroyed and the University became, soon after 1939, a new setting for adepts to the fascist regime, who took over many of the old chairs of professors now in exile abroad or in jail. In 1994, the prestigious Spanish chemist Francisco Giral published a book entitled: *Ciencia española en el exilio (1939–1989),* in which he denounced how around 500 top Spanish scientists left the country after 1939 (Giral 1989; Claret 2006). Giral reported that almost the half of the

[1] "Al término de la cruenta guerra mal llamada 'civil'… cerca de la mitad del profesorado numerario de las 12 Universidades de que entonces contaba la Universidad española, quedó incapacitada para la enseñanza y la investigación científica, por quedarse en la tierra perdiendo la vida, la libertad, la salud o la cátedra o bien por elegir el camino del exilio a cambio de alejarse de la tierra".

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permanent academic positions from the 12 Spanish universities of the 2nd Republic (1931–1939) irreversibly was closed and how professors lost their chairs. The consequences were painful: research schools were dramatically broken up and generations of scholarship lost; the new appointees were subjected to severe ideological control in an authoritarian university, at first very isolated from international trends. In 2006, Luis Enrique Otero Carvajal quantified the process of "depuration" of the teaching staff of the *Universidad Complutense de Madrid*; Carvajal showed very convincingly how the new Francoist university represented a serious backward step for the Spanish academic system (Otero Carvajal et al. 2006). In fact, there is a general consensus that, in the early period of the dictatorship, the university system suffered a severe amputation of a large number of its most brilliant pre-war members, and was aggressively controlled by a regime with a fascist (Falangist) ideological bias. In addition, from its foundation in 1939, the CSIC took over all the seminal research projects of the new regime, and initially weakened the already fragile university system (Malet 2008, 2009).

The 1943 University Act (Ley de Ordenación Universitaria, LOU) reflected very well the abrupt break with the democratic past of the 1930s and the fascist values of the new academic culture of the early years of the dictatorship. It set up a strongly centralized university system, in which rectors were directly appointed by Franco and were at the same time MPs of the *Cortes Españolas* – a totalitarian parliament under the rigid control of the dictatorship. Standard Spanish textbooks were mandatory, with scientific content deeply ideological and highly influenced by neo-scholastic and fascist values, and students suffered the rigid control of the Sindicato Español Universitario (SEU) (de Riquer 2012, pp. 325–330; Ruiz Carnicer 2005, pp. 113–138; Giner 1976, pp. 183–211). In addition, research was detached from the University to strengthen the CSIC's capacity to build new links of 'applied science' to industry, but also to re-establish international connections with the scientific community abroad, as an important strategy for the progressive legitimization of the regime.

Nevertheless, the academic landscape gradually changed during the 1950s. Ignoring, or at least undermining in public, the contribution of their masters from the pre-Civil War generation, the new elite scholars accommodated themselves to the regime, and contributed actively to the academic reforms of the dictatorship. Many were keen to emphasize the differences between the JAE and the new CSIC. In their view the old weak and scattered efforts were surpassed in the new regime by a systematic quantitative growth of research activity, which spread for the first time throughout Spain, and seriously attempted to be useful to industry. The CSIC was then perceived as the 'first' institution that established a full research plan for the country and a well-defined professional career path in science and technology (Lora-Tamayo 2002, p. 259).[2] In the old days of the JAE, isolated individuals and small research groups were perceived as disconnected from the needs of Spanish

[2] "A partir de 1940, el CSIC, asociado en su feliz creación al nombre del Ministro Ibáñez Martín, empieza a desarrollarse siguiendo, de una parte, la misma política de la JAE en la formación y el cultivo del personal investigador, y abriéndose de otra, a la subvención de la investigación universitaria allí donde hubo un grupo de garantía y a la creación de una diversidad de Institutos propios con un criterio de dilatación de posibilidades de trabajo a todos los lugares de España".

society,[3] whereas the new science under Franco was for the first time part of a real state policy, implemented through the CSIC, the *Instituto Nacional de Industria* (INI) and the *Patronato Juan de la Cierva* (PJC) with its network of research institutes (Lora-Tamayo 1963, p. 8).

After the "autarkic" forties, in the 1950s the regime gradually gained international recognition, while the unwavering control of the University by the Falangist party began to fade away. 1953 has been considered by many as the 'annus mirabilis' of the dictatorship. This was the year of the first official agreement with the United States, which legitimized Franco in the context of the Cold War, but also the year of the Concordat with the Vatican, which gave the regime the explicit support of the Roman Catholic Church. All this was combined with a substantial increase in foreign investment, and the progressive opening-up of Spanish frontiers to international trade and tourism. There was a trend towards liberalization of the economy, but in an authoritarian, non-democratic political framework, which obviously included the university system. That cocktail of contradictions spilled over into the 1960s, in particular in the period 1962–1968 in which the chemist and conservative catholic Manuel Lora-Tamayo, (1904–2002) acted as Minister of Education and Science in Franco's cabinet. In line with the changing times, academic reforms seemed urgent, but their nature and extent would soon become, as we will see, a matter of bitter disagreement.

There is general consensus on how the 1960s substantially transformed the academic atmosphere of Western universities. An average student at that time found institutions full of indifferent professors dispensing advice, endless bureaucracy, huge lecture halls, and excessive textbook culture, all combined with paternalistic warnings against sexual promiscuity and political activism. In addition, in the context of the Cold War, universities were desperately seeking lucrative research contracts, often linked to military aims, in an applied-science utilitarian atmosphere. In that context, many students, looking for intellectual fulfillment rather than simply a professional career, felt deeply disappointed and shifted quickly to more radical positions (Degroot 2008, pp. 90–97; Farrell 1999; Agar 2008). As Tom Buchanan described in his big picture of post-war Europe (Buchanan 2006, pp. 142–143):

> The student radicalism must be seen in the context of far more extensive social and cultural change, in particular the growth of prosperity and affluence, liberal reforms in the realm of social and sexual behavior, the rise of a new, more critical intellectual culture and the declining authority of the churches.

There have been different historiographical interpretations to broadly explain student activism in the 1960s. Delusion theories presented students as the spoiled children of the bourgeoisie and the middle classes; generational factors justified their

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[3] "No hay muchas posibilidades en estas primeras décadas del siglo para el desarrollo de una tarea continua y creciente; tampoco un clima demasiado favorable ni en la Universidad ni fuera de ella para lograrlas" (Lora-Tamayo 1951, p. 39); "Con unos restringidos núcleos de trabajo, pues, en algunas, muy pocas Facultades, universitarios tan llenos de entusiasmo como escasos de posibilidades, algunas instituciones científicas como las enumeradas, perfectamente concebidas y con rendimientos dignos de la categoría de quienes las dirigían, pero reducidos en número para la obligada dilatación de la ciencia, y con una casi absoluta falta de proyección aplicada en la investigación, se llega al período que hemos de comentar ahora" (Lora-Tamayo 1963, p. 7).

discontent in terms of the deep break between generations after WW2; whereas others framed student movements in the context of a crisis of liberal-democratic values and class conflict in Western societies (Hilwig 1998, p. 323; Picon 1988; Tarrow 1989). In the late 1960s, the elites addressed the public sphere as defenders of democracy and order, supporting the silent majority and protecting students from "dangerous", "radical" foreign influences. But students' main criticism focused on the failure of new democracies to face their recent authoritarian past. They also denounced the political apathy of the new consumer societies—here Herbert Marcuse's *One-Dimensional Man* became a text of reference for student movements—together with the alienation produced by the new mass media (Hilwig 1998, p. 342).

Student unrest, from Berkeley to Paris, was probably just another sign of the profound crisis of the university system in the sixties, in which traditional values and social behavior were profoundly questioned. However, far from general descriptions of that complex historical problem, university agitation and public controversies should be placed in particular historical contexts (Hilwig 1998, p. 332; Maiocchi 2004).[4] This is even more urgent when referring to peripheral countries with authoritarian regimes that survived after WW2. In those contexts, concepts such as freedom of expression, and liberal, democratic values acquired specific meanings, which should be carefully analyzed. This was, for instance, the case with General Franco's military dictatorship ,during the 1960s in Spain.

In the last decades, the history of Spanish universities in the 1960s has often been treated as part of a more general cultural history of Franco's dictatorship and in particular of the movements of political resistance against the regime (Carreras and Ruiz Carnicer 1991; Hernández et al. 2007; Ruiz Carnicer and Gracia 2004; Lusa and Roca-Rosell 2005). Historians have devoted serious attention to the repressed, but more work has to be done on the repressors in a broad sense, from police arrests and torture of opponents of the regime to more subtle collaborations with the dictatorship, which obviously included university professors and intellectuals as a whole (Gómez Rodríguez and Canales Serrano 2009). We already have excellent historical reconstructions of the ways in which intellectuals broadly adapted to the new order (Gracia 2006), but there is still a lot to be done to recover more voices of historical actors in those times of political and social agitation: from student unions and intellectuals' manifestos against Franco to professional elites supporting the dictatorship (Lewis 2002). For that purpose, in this chapter, I will describe the pivotal role played by Manuel Lora-Tamayo as a professional scientist and Minister of Education and Science. Through the analysis of his reform projects and their contestation, I attempt to depict the main features of the Spanish university system in the period 1962–1968, in the heart of the iconic sixties. I will also describe how those reforms were implemented under a strong rhetoric of technocracy and frequent public statements of an apolitical nature, aiming to delegitimize democratic, liberal opposition from student unions and university professors.

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[4] "…unless we place the movements of the late 1960s within their national and historical contexts, we shall not be able to judge either their newness, their breadth, or their impact on democracy" (Hilwig 1998, p. 332).

10.2 From Autarky to Technocracy: the 'Crisis' of the University in the 1960s

After the Civil War, in the early years of autarky and repression the Spanish university system held roughly 35,000 students, but figures had doubled to more than 60,000 by the early 1960s, and by the early 1970s the Spanish university population was already close to 200,000 students. Figures were quite impressive indeed. The economic liberalization of the late 1950s provided an average growth in annual GDP of 7.5 % from 1960 to 1973, which also led to booming exports and a serious decline in rural population. In addition, national frontiers opened up to foreign commodities and persons. In 1970, for instance, 30 million tourists, mainly from Northern Europe, visited Spain (Buchanan 2006).

It was in that context that, in 1962, Lora-Tamayo joined Franco's cabinet as Minister of Science and Education. Close to the Opus Dei right wing catholic organization (Estruch 1995), and to the group of new ministers known as "technocrats", he entered the new reshuffled government with a well-deserved reputation as a prestigious scientist, well connected internationally (Lora-Tamayo 2002, p. 340).[5] During the Civil War, being a member of the association *Acción Católica*, Lora-Tamayo had already felt comfortable with the political project of the military rebels (Lora-Tamayo 2002, p. 88).[6] In 1942, he obtained the chair of Organic Chemistry at the Faculty of Sciences in Madrid,[7] and soon became director of the *Instituto de Química Orgánica* at the CSIC. In the fifties, he had already accumulated an enormous amount of academic power (Lora-Tamayo 1948, p. 64).[8]

In 1962, after his appointment as Minister of Education and Science, in the opening session of the 1962/1963 academic year at the University of Madrid, Lora-Tamayo sketched out his plans for the Spanish university system. He designed a reform of the teaching staff, the creation of new faculties in the provinces, a new stimulus for research with more public funds, a closer collaboration between the

[5] On 16 November 1962, Lora-Tamayo was awarded a *Doctor honoris causa* at La Sorbonne, in Paris, probably a sign of fruitful relations between Franco's regime and General De Gaulle's government. In the context of the Algerian War, and despite the critical reception among French students, distinguished Gaullist figures, such as Louis Jaquinot, Minister of State and Gaston Mennerville, the president of the Senate, were present at the formal ceremony in the amphitheater of La Sorbonne. The opposition to the rector, the historian Jean Sarrailh, was counterbalanced by some of Lora-Tamayo's 'friends' in the governing body at La Sorbonne: Jean Courtois, professor of Biochemistry, Raymond Delaby, professor of Chemistry, and also another biochemist, Jean Roche, who succeeded Sarrailh as Rector.

[6] "La figura ya histórica de Franco y la positiva efectividad de su obra en el desarrollo de España me impresionaron siempre".

[7] At that early stage of his career, Lora-Tamayo had already published on the problem of the Spanish University (Lora-Tamayo 1941).

[8] Lora-Tamayo was Vice-rector of the Universidad de Madrid, professor of the *Escuela Superior de Armas Navales*, a member of the *Academia Real de Farmacia*, of the *Academia de Medicina de Sevilla* and the *Academia de Buenas Letras de Sevilla*, and the *Academia de Ciencias y Artes de Barcelona*, and head of Organic Chemistry at the *Instituto "Alonso" Barba de Química* at the CSIC.

University and the CSIC, and a certain autonomy in University management, which included the creation and promotion of new private universities under the control of the Catholic Church (Lora-Tamayo 1962a or 1962b). Concerning academic staff, Lora-Tamayo attempted to reduce the power that senior professors (*catedráticos*) enjoyed in the earlier authoritarian, autarkic University. He reorganized faculties in departments and created a new category of professor, the *agregado* (a sort of assistant professor, at an intermediate level between the powerful *catedráticos* and the *ayudantes* and *adjuntos*). He was also keen to encourage full-time devotion of academic staff to university tasks, which was not very common in the weak academic system of the Spanish University (Lora-Tamayo 1962a, b, 1963, 1965a, b, c, 1966, 1969).

The whole reform project was presented under a 'technocratic' banner, defending the supposed 'neutrality' of scientific enterprise. In 1965, during the discussion of a new Education Bill at the *Cortes Españolas*, Lora-Tamayo emphasized the neutral and objective nature of his project: "In the University as an institution, as in the Church, the Army or the Judicature, there cannot be groups or political factions… everyone should leave his personal ideals at the entrance …".[9] Although he accepted rhetorically a certain freedom of expression in every chair – we should remember that this had been a controversial issue in the Spanish University since the last decades of the nineteenth century (Nieto-Galan 2012)-, and he insisted on the exclusion of any political agitation or proselytism. Even in a public address on the utility of scientific research for military needs, Lora-Tamayo again pointed out the neutral and apolitical character of science. He referred to the thesis of Albert Wohlsteller, one of the well-known experts on Cold War defense policies in the US, in the following terms: "Since they are only interested in the clarification of truth, scientists are free from dishonesty and from the ambiguous motives of traditional actors in the political arena".[10] During his Ministry, that technocratic character of the reforms was often combined with a sense of scientific cosmopolitanism, which contributed efficiently to the international legitimization of the regime. He perceived the period 1940–1950 as politically isolated, and convalescent from the Civil War, but he clearly envisaged the need to recover old international contacts by travelling abroad and inviting numerous foreign scientific luminaries (Lora-Tamayo 1948).[11]

Lora-Tamayo was also keen to increase scientific research in the University, funded in part with the budget of the *Plan de Desarrollo* (1964–1967) (Santesmases

[9] "….en la Universidad, como institución, lo mismo que en la Iglesia o en el Ejército o en la Magistratura, no puede caber grupos o facciones políticas….cada uno debe dejar a la entrada su ideario personal…." (Lora-Tamayo 1965b, pp. 21–22).

[10] "Los científicos están libres de las insinceridades y ambiguos motivos de los tradicionales actores de la escena política, porque solamente están interesados en la clarificación de la verdad" (Lora-Tamayo 1969, p. 18).

[11] In 1963, for instance, he played a crucial role in the invitation of Adolf Butenandt, a prestigious organic chemist, and director of the Max-Planck Gesellschaft, to visit Spain. The so-called *Festival Butenandt* had a considerable public impact. In 1965, a 100 foreign scientists, including six Nobel Prize winners, were invited to Spain to celebrate the 25th anniversary of the foundation of the CSIC (Presas 2008, pp. 202–204).

2008, p. 318). After the hegemony of the CSIC in the 1940s and 1950s, universities began to play a significant role in several research projects. In 1964, he supervised the publication of a comprehensive report on the state of the art of scientific research, in collaboration with the OECD, which appeared in 1966 (*La investigación científica* 1966), aiming to link University research with industrial projects.[12]

10.3 Dissenting Students and Professors: Struggling for a Liberal University

Lora-Tamayo's university reform movement faced difficulties at different levels. Keepers of the authoritarian tradition of the 1940s and 1950s in a University basically controlled by fascist-like *Falangistas*, disliked the attempt to change the status of *catedráticos*, and steered corporative resistance to the reforms. In addition, a majority of *catedráticos* opposed the official recognition of private universities of the Catholic Church, which they perceived as a serious challenge to a state centralized (and totalitarian) university system. On the other hand, in the 1960s the regime was already unable to silence all liberal and leftist voices demanding political and academic freedom among student associations and young lecturers.

Concerning the student movement (Colomer 1978; Gracia, 1996; *Universitat* 1968), the crisis of the SEU, the old Falangist students' union, was a clear symptom of the increase in student opposition to the values of the dictatorship. Although some early symptoms of crisis had already appeared in the 1950s—in particular in 1956—it was in the 1960s when the agitation occupied the classrooms (París 1991). After some attempts at mild liberalization by Minister Joaquín Ruiz Giménez (1913–2009) in the fifties, the 1960s became an ideal laboratory for new technocratic plans often linked to the increasing influence of Opus Dei in Franco's cabinet (Tusell 1984). In that context, student movements began to build serious opposition to foreign military bases—as a result of Franco's agreement with the US after 1953—which was linked to growing sympathy for Marxist, communist ideas supporting the working class, but also achieved broad consensus in the fight for democracy, freedom of expression and solidarity with political prisoners of the regime. Economic and demographic growth contributed to the rise in social demand for a better education coming from the emerging middle classes, which had a great impact on the University.

In spite of the difficulties, clandestine but democratic student associations soon began to oppose the authoritarian SEU, and spread a list of concrete political demands, which can be summarized as follows (Fernández Buey 1991): new demo-

[12] As in other totalitarian regimes, such as Nazi Germany, many scientists and University professors remained formally "apolitical", but effectively served the interests of the regime through "technocratic projects" (Ash 1995). As stated by theoretical sociologist Niklas Luhmann: "though attempts at political influence on science have plainly been made, these are registered only as temporary 'irritations', that tend to disappear sooner or later" (Ash 1999).

cratic student associations, autonomy for the University, a profound democratic reform at the academic and social levels, amnesty for political prisoners, and freedom of expression inside and outside the University walls. In 1968, at the University of Barcelona student demands issued by the *Sindicato Democrático de Estudiantes* (SDE)—already constituted in 1965 after the crisis of the Falangist SEU—were even more concrete: freedom of association and legal recognition of the SDE; withdrawal of all sanctions and arrests, along with the repeal of the *Reglamento de Disciplina Académica* (A disciplinary Act); democratization of the University government bodies, including the immediate resignation of the Rector of the University of Barcelona, and the Minister of Education and Science, Lora-Tamayo (*Universitat* 1968).

The student movement had already borne its first fruit with the creation of the SDE, which contributed to the official closure of the SEU. This was formally replaced in the Ministry by new associations such as the "*Asociación professional de Estudiantes*" (APE), but these enjoyed little success. An event that powerfully symbolized the new students' democratic resistance took place in March 1966 (La Caputxinada), at a Monastery in Barcelona in which students and professors gathered "illegally" to draw up new statutes for the SDE (Crexell 1987). In Madrid, fierce repression came immediately from Lora-Tamayo's Ministry, in collaboration with the *Ministerio de Gobernación*, which was responsible for the police and public order (Fernández Buey 1991, pp. 480–482). Police entered several faculties and hundreds of students were expelled from the University, together with a group of distinguished professors who had already opposed the authoritarian values of the University some years earlier.[13] As a reaction to that fierce repression, student political commitment grew, and posed a serious obstacle to the Ministry.[14]

Strongly influenced by communist ideas, students also became active writers of clandestine journals and pamphlets. In Barcelona, for instance, university students belonging to the Catalan communist party, the PSUC (*Partit Socialista Unificat de Catalunya*), spread bitter criticism of Lora-Tamayo's policies. They denounced marginalization of lower class students in their access to the University and the precarious working condition of professors: in the period 1965–1968, more than 70 lecturers and 50 students were expelled from the University of Barcelona, and three professors and 40 students from the University of Madrid, all combined with thousands of sanctions, arrests and trials against students all over Spain (*Universitat* 1968).

After the crisis of 1965, student repression was complemented with the expulsion from the University of a group of outstanding scholars who had already expressed dissent with the regime in earlier years. After the first proceedings opened, others

[13] Solé Tura, Bricall, Raventós, Roca, Fontana, Lluch, Molas, Boigas, etc. (Colomer 1978, pp. 257–258).

[14] "A medida que la represión de los años de Lora-Tamayo ….se impusiera sobre los estudiantes, con redadas y cierres generalizados; a medida que el expediente y la sanción se conviertan en una desgraciada rutina, su impacto demoledor reforzará y amplificará la conciencia política de miles de escolares" (Hernández et al. 2007, p. 184).

quit the University in solidarity. Many went into exile abroad, others resisted in Spain, but a great majority kept on discussing in public the problems of the University in the 1960s under Franco's regime. It is precisely by examining several critical texts written by these dissidents, and contrasting their thesis with Lora-Tamayo's official stance, that we can refine this analysis.

Among those expelled, one the most famous professors was José Luis López-Aranguren (1909–1996), a prestigious philosopher and intellectual, who soon denounced the 'political' problem of the Spanish University in the late 1960s. In a text of 1968, published in 1973 in his book on the future of the University, López-Aranguren's diagnosis was clear.[15] He was especially keen to challenge the technocratic, apolitical rhetoric of the regime, in which Lora-Tamayo played an active part, to bring to the fore the deep political dimension of the University's problems.[16]

López-Aranguren was particularly critical of Lora-Tamayo's University Act of 1965 (López-Aranguren 1973, p. 62). He felt that the creation of the new category of *agregados*, together with the new organization of faculties into departments did not hinder the authoritarian tradition of the system: "[the regime] replaces the old Falangist totalitarianism with a new bureaucratic-regimental totalitarianism".[17] He believed that the new pyramidal military-like structure was a clear sign of the political dimension of the problems that the Ministry wanted to avert with the rhetoric of technocracy: "as in the old times, now with Western democratic words, authoritarian attitudes are concealed".[18] He denounced the lack of liberal tradition—in terms of freedom of expression and real institutional autonomy—in the Spanish university system, in a reform that in practice gave more freedom only to the Catholic Church for the official legitimization of new private universities.

Enrique Tierno Galván (1918–1986) was another academic luminary who suffered repression during Lora-Tamayo's ministership. Professor of law and philosophy, Tierno Galván was a prominent political figure in democratic Spain after Franco's death, becoming one the most popular mayors of Madrid (1979–1986) (Tierno Galván 1981). In 1963, Tierno had already expressed great concern over the death penalty of the Communist leader Julián Grimau (1911–1963), a tragic event that stirred anti-Franco attitudes in Spain and abroad. Together with López-Aranguren, Tierno Galván organized regular seminars that critically addressed the authoritarian aspects of the dictatorship and the lack of academic and political freedom. In 1965, Tierno's support for student protests and his public disagreement with later repres-

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[15] "….nuestros gobernantes, pese a su fachada tecnocrática y los Planes de Desarrollo, no se han percatado aún de la enorme importancia estrictamente económica ….de la inversión en educación…La Universidad, considerada desde una perspectiva política, es asunto no sólo secundario sino que, últimamente [1968], se está convirtiendo en molesto" (López-Aranguren 1973, p. 51).

[16] "Y esto se afirma por un régimen que politizó cuanto le fue posible esta misma Universidad y que, por otro lado, cierra toda posibilidad de manifestarse políticamente en ninguna otra parte" (López-Aranguren 1973, p. 59).

[17] "[el régimen] substituye el viejo totalitarismo falangista por un Nuevo totalitarismo burocrático-regimental" (López-Aranguren 1973, p. 64).

[18] "con palabras democrático-occidentales se están recubriendo actitudes tan autoritarias como las anteriores" (López-Aranguren 1973, p. 72). See: *ABC*, 28/02/1965.

sion led by the *Ministro de Gobernación*, Camilo Alonso Vega (1889–1971), caused him to be expelled from his University chair in Salamanca and forced into exile at Princeton (Tierno Galván 1981, pp. 344–350). López-Aranguren, Tierno Galván, Agustín García Calvo (1926–2012) and Santiago Montero Díaz (1911–1985) were formally expelled, but other professors, such as José María Valverde (1926–1996) and Antonio Tovar (1911–1985) quit their chairs in solidarity.[19]

Other critical statements came from professor Antonio Tovar, a distinguished philologist with a considerable international reputation (Tovar 1968). Although Tovar had originally adjusted to the new rules of the dictatorship in the 1940s, the exit of Ruiz Giménez from the cabinet in 1956 became a turning point in his increasing political uneasiness. After the events of 1965, Tovar moved to the University of Illinois, and publicly expressed several disagreements with Lora-Tamayo's policies. Tovar was particularly opposed to the legalization of Catholic Universities, and seriously questioned the idea of University "freedom" issued from the Ministry. In his own words: "It is obvious that the Minister of Education cannot talk without mental restrictions about "free" Universities, while article 26 of the Concordat with the Vatican is still law…".[20] In contradiction with the agreements of the 2nd Vatican Council, article 26 of the Spanish Concordat stated that any teaching institution had to adapt its syllabus to Catholic dogma and morality. Tovar advocated a serious revision of the traditional faculties, more autonomy in the appointment of new lecturers, and pure, basic research not necessarily dependent on the CSIC and technocratic industrial needs (Tovar 1968, pp. 138–146; Latorre 1964).

After the crisis of 1965, controversies and social agitation against the Ministry reforms continued, and were followed by more repression in 1966 and 1967—in February that year universities were closed in Madrid and Barcelona—leading finally to high social and political tension in 1968. After 1st of May 1968, radicalization of the student movement and critical positions against Lora-Tamayo's University reforms increased. The creation of the new *Policía de Orden Universitario* (POU) in January 1968 for the internal control of student political activities inside the faculties made things even worse. In March, brutal police repression of students in Madrid had already forced Lora-Tamayo's resignation. His rhetoric of neutrality and technocracy in line with the new reshuffled cabinet in the early 1960s turned out to be insufficient to keep him in power.

There is still, however, controversy among historians when assessing the exact reasons for Lora-Tamayo's resignation. We can depict him as a victim caught between the liberal democratic opposition and the old Falangist totalitarian forces of the regime in permanent tension with the new technocratic members of Opus Dei in

[19] "El proceso concluiría políticamente de acuerdo con unos supuestos previos trazados por el jefe del Estado [Franco] o por cualquiera de los ministros que actuaban como guardadores del régimen dictatorial" (Tierno Galván 1981, p. 348).

[20] "Es evidente que el Ministerio de Educación no puede hablar sin restricciones mentales de Universidad 'libre' mientras siga siendo ley del Estado Español el artículo 26 del Concordato con la Santa Sede…." (Tovar 1968, pp. 118–119).

the 1960s.[21] But we could also present Lora-Tamayo's last days in the Ministry as a personal defeat in the face of the international revolutionary atmosphere of 1968, which permeated even into peripheral and dictatorial countries like Spain. [22] From the internal logic of Franco's cabinet, his actions would even have been too soft in comparison with the fierce police repression led by the *Ministro de Gobernación*, being unable to control the underground political agitators in a very unstable University system.[23] As Paul Lewis described some years ago in his analysis of the Latin fascist elites:

> …Lora-Tamayo clashed with the Interior Minister, General Camilo Alonso Vega. The Education Minister had protested strongly after the police cracked down pitilessly on student protesters, but Franco stood behind his old friend (Lewis 2002, p. 100).

Conclusion

In spite of Lora-Tamayo's eventual resignation in 1968, his attempts at University reform and the opposition that this fueled are useful indications of the nature of the crisis of the university system in Spain in the 1960s. Although some general patterns of the academic culture of the sixties can be applied to different countries, there is no doubt that the Spanish case had its own particularities, in a period in which Franco's dictatorship was progressively opening up its frontiers and liberalizing the economy. For the regime elites—which obviously included Lora-Tamayo in his role as leading scientist, Minister of Education and Science and a very influential person regarding the science policies of the regime—demographic and economic growth supported all sorts of technocratic apolitical reforms, which were also applicable to the University. Hierarchical, authoritarian organizations had to be adapted to new economic, industrial needs. But, in the logic of the Cold War, they systematically isolated the political load of knowledge creation from its applications.

In spite of all protests and agitation, the elites considered that the emerging Spanish "liberal" economy of the sixties did not necessarily require a "liberal" academic environment. In spite of witnessing fierce repression of students and professors, scientists, intellectuals and academic authorities frequently expressed those apolitical attitudes in public. That technocratic strategy was obviously useful for the

[21] "Mancada de support pel flanc de les forces i l'opinió democràtiques, la política de Lora-Tamayo va ser bombardejada obertament i agressiva pels sectors d'origen falangista més afincats al règim. L'afer forma part de les purgues constants entre el Movimiento i les tendències tecnocràtiques de l'Opus Dei, que arrancaven de la crisi de 1956–57, i que no pararien fins a la mort de Franco" (Colomer 1978, p. 310).

[22] "….M. Lora-Tamayo, desbordado, acabó por dimitir a principios de 1968, dejando en herencia…..una Universidad agitada en todos sus frentes y necesitada de reformas que no fuesen del todo pusilánimes o que se quedaran a medio camino" (Hernández et al. 2007, p. 158).

[23] "…Manuel Lora-Tamayo, acusado de ser excesivamente blando y demasiado complaciente frente a la influencias de los agentes infiltrados desde el exterior, siempre considerados comunistas, que habrían acabado por contagiar irreversiblemente a los estudiantes españoles" (Hernández et al. 2007, p. 263).

legitimization of Franco's regime, even with the apparent openness of the expected University reforms.[24]

As Mark Walker emphasized in the case of Nazi Germany, scientists as "fellow travelers" neither resisted Hitler, nor embraced National Socialism. They became 'apolitical' professional scientists doing 'good' science independently of their employer. In Walker's words (Walker 1995, p. 4):

> If we want to understand how National Socialism affected German Science, we cannot restrict ourselves to the few scientists who enthusiastically embraced the 3rd *Reich*, and those even fewer scientists who actively and consistently resisted it. Instead, we must also include those very many scientists who neither resisted nor joined Hitler's movement, rather who went along for the ride.

In the 1960s, technocracy and apolitical statements were again at the core of the rhetoric of the regime's academic reforms. The Nazi Ministry for Education and Science described the German scholarly tradition as objective and conforming the scholarly ethos to serve the subject, not political interest: science as a neutral, objective and (to some extent) international activity. This trend continued after 1945. For many German professors after 1945—we should not forget the longstanding influence of the German academic world on the Spanish system after the 2nd World War—"to be proficient in their field of study remained above the petty squabbles of politics" (Hammerstein 2003, p. 175, 177).

In 1996, Lora-Tamayo was interviewed for the newspaper *Ya* after a commemorative gathering at the *Centro Nacional de Química Orgánica*. Asked about his period as Minister of Education, his answer was astonishing, to say the least:

> What are your memories as Minister?
> Bad ones. I had a very bad time. *I am not a politician*. I was Minister because it was at that time a moral obligation, but I also resigned when I considered it was morally necessary ….
> When I was asked, I first thought of not accepting the position – I had many reasons not to.
> … *I am totally out of politics. I have only been a researcher*.[25]

In another interview for a book about all Franco's Ministers, and when asked about the reasons for his acceptance of the post of Minister of Science and Education, Lora-Tamayo stated that Franco's persona and the positive efficiency of his work had always impressed him.[26] He described himself as neither belonging to the Falange nor to Opus Dei, but as having contributed to a substantial reform of the Spanish University.

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[24] In the same vein, Lora-Tamayo used to express his criticism of the ideological content of *Arbor*, the official journal of the CSIC, which in his view, seldom gave room to "real, objective" scientific papers by contrasting it, for instance, with the more "objective" journal *Revista de Ciencia aplicada* (Lora-Tamayo 2002, p. 267).

[25] "Malos. Yo lo pasé muy mal. No soy político. Fui ministro porque las circunstancias me obligaron moralmente a serlo, pero también presenté mi dimisión cuando moralmente vi que debía presentarla….Cuando me llamaron pensaba no aceptar, tenía muchas razones para ello. …Yo estoy alejado totalmente de la política. Sólo he sido investigador", *Ya*, 04–03-1996 (my emphasis).

[26] "La figura histórica de Franco y la positive efectividad de su obra en el desarrollo de España me impresionaron siempre" (Bayod 1983, p. 127).

Behind that rhetoric, the fact is that the Lora-Tamayo reform agenda was at the core of important tensions of the Spanish academic elites in the 1960s. The real power of university departments was often questioned by traditional chairs (*cátedras*) and the new *agregados* faced difficulties for years trying to find their right place in a hierarchical, authoritarian academic system; the tension between pure and applied research and their funding put the CSIC in a new, more collaborative position towards universities, but not without resistance; the official recognition of private universities for the Catholic Church became another source of high conflict and also encountered resistance among the most totalitarian circles issued from the LOU from 1943 onwards; and finally the repressed demands of political and academic freedom soon became a source of progressive discredit of the regime among the emergent new middle classes.

At the end, all reforms, resistances and repression under Lora-Tamayo's ministry are just symptomatic of the 1960s social, institutional and political agitation of a totalitarian regime, which progressively became authoritarian, to finally reach some liberal democratic values, in 1975, after Franco's death.

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References

Agar, Jon. 2008. What happened in the sixties? *The British Journal for the History of Science* 41(4): 567–600.

Ash, Mitchell. 1995. Essay review: Science, technology and higher education under nazism. *Isis* 85: 458–462.

Ash, Mitchell. 1999. Scientific changes in Germany, 1933, 1945, 1990: Towards a comparison. *Minerva* 37: 329–354.

Bayod, Angel, ed. 1983. *Franco visto por sus Ministros*. Barcelona: Planeta.

Buchanan, Tom. 2006. *Europe's troubled peace, 1945–2000*. Oxford: Blackwell.

Carreras, J. J., and M. A. Ruiz Carnicer, eds. 1991. *La Universidad bajo el régimen de Franco (1939–1975)*. Zaragoza: Institución Fernando el Católico.

Claret, Jaume. 2006. *El atroz desmoche*. Barcelona: Crítica.

Colomer, Josep Maria. 1978. *Els estudiants de Barcelona sota el Franquisme*. Barcelona: Curial.

Crexell, Joan. 1987. *La Caputxinada*. Barcelona: Edicions 62.

de Riquer, Borja. 2012. *La dictadura de Franco*. Barcelona: Crítica/Marcial Pons.

Degroot, Gerard. 2008. *The 60s unplugged. A Kaleidoscopic History of a disorderly decade*. London: MacMillan.
Estruch, Joan. 1995. *Saints and Schemers: Opus Dei and its Paradoxes*. Oxford: Oxford University Press.
Farrell, James. 1999. *The spirit of the sixties: The making of postwar radicalism*. London: Routledge.
Fernández Buey, Francisco. 1991. Estudiantes y profesores universitarios contra Franco. De los sindicatos democráticos estudiantiles al movimiento del PNN (1966–1975). In *La Universidad española bajo el régimen de Franco (1939–1975),* eds. J. J. Carreras and M. A. Ruiz Carnicer, 469–496. Zaragoza: Institución Fernando el Católico.
Giner, Salvador. 1976. Power, freedom and social change in the Spanish University, 1939–1975. In *Spain in crisis: The evolution and decline of the franco regime,* ed. Paul Preston, 183–211. New York: Barnes & Noble.
Giral, Francisco. 1989. *Ciencia española en el exilio (1939–1989)*. Madrid: Amigos de la Cultura Científica.
Gómez Rodríguez, Amparo, and Antonio Canales, eds. 2009. *Ciencia y fascismos. La Ciencia Española de Posguerra*. Barcelona: Alertes.
Gracia, Jordi, 1996. *Estado y Cultura. El despertar de una conciencia crítica bajo el franquismo (1940–1962)*. Toulouse: Presses Universitaires du Mirail.
Gracia, Jordi. 2006. *La resistencia silenciosa. Fascismo y cultura en España*. Barcelona: Anagrama.
Hammerstein, Notker. 2003. National Socialism and the German Universities. *History of Universities* 18(1): 170–188.
Hernández, Elena, M., Angel Ruiz Carnicer, and Marc Baldó. 2007. *Estudiantes contra Franco (1939–1975). Oposición política y movilización juvenil*. Madrid: La Esfera de los Libros.
Hilwig, Stuart J. 1998. The revolt against the establishment: Students vs. the press in West Germany and Italy. In *1968: The world transformed,* eds. Carole Fink, Phillip Gassert, and Detlef Junker, 321–350. Washington: Cambridge University Press and the German Historical Institute.
La investigación científica y técnica y sus necesidades en relación con el desarrollo económico de España. Dirección General de Promoción y Cooperación Científica. 1966. Madrid: Ministerio de Educación y Ciencia.
Latorre, Angel. 1964. *Universidad y Sociedad*. Barcelona: Ariel.
Lewis, Paul H. 2002. *Latin fascist elites. The Mussolini, Franco and Salazar regimes*. Westpoint CT and London: Praeger.
López-Aranguren, José Luis. 1973. *El futuro de la Universidad y otras polémicas*. Madrid: Taurus.
Lora-Tamayo, Manuel. 1941. Orientaciones para una posible reforma de la Facultad de Ciencias. *Revista Nacional de Educación* 1(2): 40–50.
Lora-Tamayo, Manuel. 1948. *Discurso leído en el acto de su recepción el día 21 de enero de 1948 en la Real Academia de Ciencias Exactas, Físicas y Naturales*. Madrid: Real Academia de Ciencias Exactas, Físicas y Naturales
Lora-Tamayo, Manuel. 1951. *La Investigación en química orgánica. Discurso pronunciado por Manuel Lora-Tamayo, en la sesión de clausura del XI pleno del Consejo*. Madrid: Consejo Superior de Investigaciones Científicas.
Lora-Tamayo, Manuel. 1962a. *Discurso del Ministro de Educación Nacional Excelentísimo Sr. Don Lora-Tamayo, Manuel, Inauguración del curso académico en la Universidad de Madrid, 3 de octubre de 1962*. Madrid: Universidad de Madrid.
Lora-Tamayo, Manuel. 1962b. *Discurso del Ministro de Educación Nacional. Inauguración del curso Académico de la universidad de Madrid, 3 de octubre de 1962*. Madrid: Gráficas Canales.
Lora-Tamayo, Manuel. 1963. *La investigación científica*. Madrid: Editora Nacional.
Lora-Tamayo, Manuel. 1965a. Estructura de las facultades universitarias y su profesorado. *Revista de Educación* 174: 17–26.
Lora-Tamayo, Manuel. 1965b. La Educación Nacional en España en 1964–65. *Revista de Educación* 174: 26–34.

Lora-Tamayo, Manuel. 1965c. *Estructura de las facultades universitarias y su profesorado. Discurso pronunciado en las Cortes Españolas (15 de julio de 1965)*. Madrid: Gráficas Juan Torroba.

Lora-Tamayo, Manuel. 1966. *Discurso en el Acto de apertura de curso de la Universidad de Granada*. s.l.

Lora-Tamayo, Manuel. 1969. La investigación al servicio de la defensa. *Arbor* 281: 5–19.

Lora-Tamayo, Manuel. 2002. *Lo que yo he conocido, (Recuerdos de un viejo Catedrático que fue Ministro)*. Puerto Real: Federico Joly y Cia- Ingrasa.

Lusa, Guillermo, and Antoni Roca-Rosell, eds. 2005. *La Universitat sota el franquisme. El Franquisme què va ser i quina herència ha deixat. III Jornades Memorial Democràtic a la UPC. 16 i 17 de novembre de 2005*. Barcelona: Càtedra UNESCO de Tècnica i Cultura.

Maiocchi, Roberto. 2004. *Scienza e fascismo*. Roma: Carocci.

Malet, Antoni. 2008. Las primeras décadas del CSIC: Investigación y ciencia para el franquismo. In *Cien años de política científica en España,* eds. Ana Romero and María Jesús Santesmases, 211–256. Madrid: Fundación BBVA.

Malet, Antoni. 2009. José María Albareda (1902–1966) and the formation of the Spanish Consejo Superior de Investigaciones Científicas. *Annals of Science* 66: 307–332.

Nieto-Galan, Agustí. 2012. A Republican natural history in Spain around 1900: Odón de Buen (1863–1945) and his audiences. *Historical Studies in the Natural Sciences* 42(3): 159–189.

Otero Carvajal Luis Enrique, et. al., (eds.). 2006. *La Destrucción de la ciencia en España: depuración universitaria en el franquismo*. Madrid: Editorial Complutense.

Otero Carvajal, Luis Enrique, and José María López Sánchez. 2012. *La lucha por la modernidad Las ciencias naturales y la Junta para Ampliación de Estudios*. Madrid: Publicaciones de la Residencia de Estudiantes y Consejo Superior de Investigaciones Científicas.

París, Carlos. 1991. La pretensión de una Universidad tecnocrática. In *La Universidad bajo el régimen de Franco (1939–1975),* eds. J. J. Carreras and M. A. Ruiz Carnicer, 437–455.

Picon, Paul. 1988. Reinterpreting 1968: Mythology on the make. *Telos* 77: 7–43.

Presas, Albert. 2008. La inmediata posguerra y la relación científica y técnica con Alemania. In *Cien años de política científica en España,* eds. Ana Romero and María Jesús Santesmases, 173–209. Bilbao: Fundación BBVA.

Ruiz Carnicer, M.A., and Jordi Gracia. 2004. *La España de Franco (1939–1975). Cultura y vida cotidiana*. Madrid: Síntesis.

Ruiz Carnicer, M.A., and Miguel Ángel. 2005. Spanish Universities under Franco. In *Universities under dictatorship,* eds. John Connelly and Michael Grüttner, 113–138. University Park: The Pennsylvania University State University Press.

Sánchez Ron, José Manuel, ed. 1988. *La Junta para Ampliación de Estudios e Investigaciones Científicas 80 años después 1907–1987*, vols. 2. Madrid: CSIC.

Sánchez Ron, José Manuel. 1998. *Un siglo de ciencia en España*. Madrid: Residencia de Estudiantes.

Sánchez Ron, José Manuel. 1999. *Cincel, martillo y piedra. Historia de la ciencia en España (siglos XIX y XX)*. Madrid: Taurus.

Santesmases, Maria Jesús. 2008. Orígenes internacionales de la política científica. In *Cien años de política científica en España,* eds. Ana Romero and María Jesús Santesmases, 293–328. Bilbao: Fundación BBVA.

Tarrow, Sidney. 1989. *Democracy and disorder: Protest and politics in Italy, 1965–1975*. Ithaca: Cornell University Press.

Tierno Galván, Enrique. 1981. *Cabos Sueltos*. Barcelona: Bruguera.

Tovar, Antonio. 1968. *Universidad y educación de masas (Ensayo sobre el porvenir de España)*. Barcelona: Ariel.

Tusell, Javier. 1984. *Franco y los católicos. La política interior española entre 1945 y 1957*. Madrid: Alianza.

Universitat. Organ del Comité d'Estudiants del PSUC. 1968.

Walter, Mark. 1995. *Nazi science. Myth, truth and the German atomic bomb*. Cambridge: Perseus Publishing.

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Chapter 11
Universities in Russia: Current Reforms Through the Prism of Soviet Heritage and International Practice

Evgeny Vodichev

11.1 Introductory Notes

The general public as well as the expert community in Russia now accept that one of the basic values the country possesses and on which it should build its future is the system of fundamental research and higher education. There is unanimity of views that this value, which had lost some of its dignity during the decades of crisis, should be revitalized, taking into consideration, however, global changes that have occurred in post-Communist Russia. Most of the experts believe that such revitalization should be based, on the one hand, on thorough consideration of previous historical experience and traditions and, on the other hand, by following basic trends in university development seen in the leading countries of the world.

The university system in Russia is now very dynamic. Just recently, within the last 5–7 years, drastic changes took place in the national higher education landscape. On the policy level, the higher education system together with fundamental research has been positioned as a foundation to a new national innovation system, which was proclaimed as a precondition for long-term economic modernization strategy. The university system was then segmented. A new research component in higher education was outlined and received direct support from the state. Higher education is now divided between the so-called Federal Universities (FU) and National Research Universities (NRU). This segmentation, however, had a long prehistory. A discourse on research universities in Russia, on their models and possibilities for their development on Russian ground began long before the current ongoing university reform. Moreover, despite the fact that university development in Russia was specific with many discrepancies compared to European models, there were some interesting experiments in setting up research in the Soviet system

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of higher education in the middle and second half of the twentieth century, which should not be neglected.

Understanding of the current university reform in Russia thus requires an in-depth historical approach. This should help to outline the specific similarities and differences of the Russian system, the historical roots of the national university system, and also to assess the feasibility of the reforms, their appropriateness and relevance to the basic trends in the evolution of international universities. Thus, in this paper I outline historical specifics and peculiarities of the development of the system of higher education in Russia, identify basic trends of university development policy in Russia today, and offer a vision regarding the feasibility of reforms in the Russian university sector through the prism of international trends and experience.

11.2 Retrospectives of the University System in Russia: Imperial Period and Soviet Transformations

The university idea came to Russia at the end of the seventeenth century. It was much later than in most of the European countries. The university idea was substantially impacted by the ideology of modernization of Peter the Great. The first professional educational establishments in Russia were closely connected with the state policy of opening the country to the outer world and broadening of its international links with Western Europe.

By the end of the Imperial period there was a network of 63 higher educational establishments in Russia. However, there were only ten universities among these with Moscow University as the largest. They were concentrated in the west, European part of the country and, as a rule, were located in big cities. In a geographical sense the exception was the Imperial University in Tomsk—the only university to operate in the east of Russia. Basically at that time Russian higher education schools including universities developed to cohere with European trends, although with some specifics. The university system was set up on the initiative of the state and developed under state control. The German (Humboldt) university model was selected as a basic one for Russian universities. However, at a later stage they picked up some elements of the French pragmatic approach. Russian universities were heavily dependent on the state. The government could legally interfere into academic issues as all curricula were to be certified by the Ministry of Education. In addition, there was a rather strong corporate culture of the professorship that impacted a university routine. In Russia advanced academic degrees and titles were linked with the civil service ranks that provided for pragmatic orientation in the university education and engagement. The universities performed the function of the centres of the educational districts in the country, which allowed the government to place civil servants in the chairs of the university management. This made the university management key figures in the system of education in the Empire. These managers typically shared the government bureaucratic ethos and approach (Andreev 2009, pp. 331–463, 524–548; Liss et al. 2012, pp. 129–145).

Thus, at the beginning of the twentieth century Russian universities, in parallel with the Academy of Sciences, also set up by Peter the Great, were centres of research activities and advanced education in the country. They were hubs of intellectual life attracting not just professors, students and researchers but Russian intelligentsia as a whole.

Substantial changes, however, took place after the Bolshevik revolution of 1917. The logic of steady development of a university system in accordance with European trends was interrupted. The university system started to be considered by the new regime as "ideologically suspicious" if not hostile, since university professors took a very reserved position towards the new authorities. In the meantime, the new regime needed professionals to make intellectuals elements of the new state machinery. Therefore, the accents in higher education development were made on technical schools with narrow profiles. As a consequence many universities lost their role as research centres or were liquidated or dismantled into minor educational facilities with limited capacity and potential.

The end of 1920s, the years of the so-called first 5-Year plan in the USSR, symbolized a shift to the modernization development strategy focused on socialist transformations. In practice this meant the start up of the coercive industrialization aimed at the fastest rates of economic development in order to reach the level of economic performance of the leading countries of the world. As is well known, this strategy brought about tremendous social and political loses to the country.

The specific model of economic growth designed by the Bolshevik planners resulted in what is referred to as 'real socialism of the Soviet type'. As noted by the Russian liberal economist Egor Gaidar (1956–2009), the model was based on state property and liquidation of private property independent of the authorities, as well as an administrative hierarchy that embraced the whole country and enforced coordination of economic activities by direct implementation of power and the liquidation of the market. The forced industrialisation focused on setting up new branches of economy to substitute import of goods and equipment and based on redistribution of resources from agriculture to industry. Strict political control and repressions that excluded any forms of unsanctioned mass activities also became important components of the new system. The new regime was supplemented by a Messiah ideology and militarism with an extremely high proportion of military expenses within the GNP (Gaidar 2005, pp. 319–320).

It might have been expected that the beginning of industrialization would open new perspectives in science and higher education in the country but in reality the outcome was very contradictory. Only those fields and directions in R&D and professional education received new prospects that could bring quick practical results and did not touch the fundamental theoretical background of sciences. All the remaining disciplines had to prove their rights to exist and develop.

Rapidly it became clear that the Soviet model of economics had started to demonstrate such 'in-built' peculiarities such as rigidity of economic structures and lack of internal stimuli to innovations (Gaidar 2005, p. 323). These shortcomings were of a fundamental, conceptual character and could not be treated by remaining within the socialist concept of development. They did not stimulate demands for R&D

products, which placed science and professional education as key elements of the innovation process in a very tricky position. In the economic policy the accent was placed on the massive import of foreign technologies. Respectively there was a need for technologists and not researchers.

After the start of forced industrialization, a shortage of qualified professionals for the fast-growing economy was identified as one of the most acute issues faced by the country. This lack positioned the system of higher professional education at the front line of technological and infrastructural support of industry. The development of a higher school became a starting point for economic modernization in Russia. Due to the specifics of Soviet modernization, priority was given to the higher educational establishments that were able to train specialists of a very practical character. A shortage of industrial engineers and a strong accent on educational functions in higher school performance resulted in systematic problems with the implementation of R&D in the higher education enterprise in the country.

A quantitative growth of higher school potential while articulating its segment focused on technical education became a long-term priority of Soviet science and educational policy. The basic trend of the 1930s in the development of the Soviet higher schools network was a concentration on setting up a variety of new educational institutions to produce technologists and engineers with narrow expertise. Most of such educational institutes were created by the disintegration of the exiting classical and technological universities. During the first 5-year plan implementation period only (1927–1931), the network of higher schools in the USSR increased from 152 to 701 institutions. However, later in the 1930s this political ploy reversed and many teaching institutes were reintegrated and the quantity decreased.

As a result, by the beginning of 1940/1941 academic year, there were 817 higher educational facilities operating in the country of which 481 were located in the territory of Russia. In 1939 some 30 % of them were situated in Moscow (82) and Leningrad (60). Except for the two 'Russian capitals' (Moscow and Leningrad), Saratov (14 educational institutes and universities), Voronezh (13) and Kazan (12) remained the largest centres of the higher professional education in Russia. In the east, only one city, Tomsk, could be included into this list with its eight institutions of higher education including the University (Chutkerashvili 1968, p. 72, 76, pp. 98–99).

Since the beginning of the 1930s the structure of the higher education system was shaped in Russia by such facilities as universities, polytechnic schools, and so-called branch schools with a narrow profile of training (medical, agricultural, teacher training, transport, mining, etc.), which in fact dominated the whole system. These were the universities that faced a lot of challenges. Throughout the whole period of the 1920s and the beginning of the 1930s they had to fight for survival as they were often referred in the Soviet political discourse as 'archaic', 'dying' and 'lagging behind real life'. The process of revival of the university system in the USSR resumed only at the end of the 1930s. By this time a new academic cohort that was presumably more loyal to the regime was substituted for many of the 'old' university professors. The new authorities streamlined the university mission to mass training of professionals instead of research, and thus their educational function was articulated. The university status was rethought in the first half of the 1930s, and a new model university chapter was elaborated and enforced by the government. Thus, Soviet universities of the 1930s did not look like the universities Russia possessed before the revolution. They did not stimulate and develop research, they did not manage to preserve the old cohorts of professors, their traditional university ethos was undermined and their curricula were ideologically biased. New professors lectured there to the new students selected on the basis of their 'proletariat origin' and loyalty to the regime rather than on academic results.

The change in educational policy and 'rehabilitation' of universities led to a fast growth of the university segment in the structure of the Soviet higher school system. There were just 11 universities in the USSR in 1932 against 21 universities in 1925. By the end of the 1930s, however, the network of classical universities was practically restored in the country; by the beginning of the 1940/1941 academic year there were 29 universities in the Soviet Union. Their R&D function also expanded but only for a very limited number of facilities. In the second half of the 1930s there were 23 research institutes under the university umbrella including ten belonging to the Moscow State University, which remained the leader of the system (Chutkerashvili 1968, p. 143, 145, 150, 151).

Numerous political repressive campaigns and show trials were the peculiar factor impacting Soviet higher education system in the 1930s. Although the coterie of higher school professors was not a specific target group for repressions, the quantity of repressed academics was substantial. Repressions against university professors led to liquidation or weakening of many scientific schools and research directions. This factor, however, had a very specific dimension with regards to the eastern part of Russia. Siberia was the recipient of many professors and scientists sent there to administrative exile. These people tried to find an opportunity to return to intellectual work in the new environment. This resulted in a rapid capacity building of some higher educational establishments in the east of the country, which substantially impacted the development of the higher educational system in Siberia at the beginning of the twentieth century; the pace of development of the classical and technological universities in Tomsk is indicative in this sense. Surprisingly enough, the same model of 'strengthening of the academic potential' in the peripheral regions of the country worked out again in the USSR of the 1930s. Such methods, however, could not compensate for the negative consequences of repressions, which were fundamental and harmful to the national system of science and higher education as a whole.

Thus, the basic model of the Soviet higher education system was finally shaped in the 1930s, including such peculiarities as a total control over higher educational establishments combined with a lack of even slight remnants of university autonomy. The research and educational functions were institutionally separated with heavy concentration on educational activity and a very limited engagement in research. This was supplemented with segmentation of the higher school into a wide spectrum of educational establishments with just minor representation of the classical universities, their full dependence on the budgetary sources of funding distributed throughout the system of economic and non-economic branches, isolation from the international university community and concentration of the university education in Moscow and Leningrad with poor representation on the peripheries.

In many important respects the Soviet approach to the higher education system symbolized a break with the pre-revolutionary university tradition in Russia. In the meantime, some features were preserved. The dominance of state control and the lack of academic autonomy are the most indicative.

11.3 Soviet Responses to Post-War Challenges: The PhysTech Model

After the end of the World War II the formation of post-industrial economics in the developed countries was on the way, and it radically changed the role of human resources in society. Effective R&D and professional education of the research type were at the starting line of this process, and their role in socio-economic development drastically changed. The capability for economic growth became just a function of the ability to develop science. Respectively, economic demands for an intellectual labour now required specific educational models capable of producing professionals with the needed qualities.

A number of new tendencies were indicative in connection with the transfer to the post-industrial era. This was 'the managerial revolution' that raised the social status of those specialists who determined socio-economic change and possessed the necessary knowledge and competences to do so. Another trend was embodied in a rapid growth of advanced technologies based on R&D, which was going beyond the military sector of economics. Knowledge and information were now considered major resources for social and economic progress. This changed the role of the higher school as a social institution and stimulated a search for a new paradigm of development for the educational system.

One more issue should not be neglected. From the historical standpoint it was the Cold War that belonged to the major determinants stimulating a search for a new educational paradigm. It touched not only upon the USSR but the rest of the governments that were playing games 'on the global chessboard', primarily the USA. According to the US historian Leslie Stuart, the Cold War redefined American science, since the Ministry of Defence became the biggest patron of R&D. Finally, this resulted in the setting up there of a "military–industrial–academic complex" (Stuart 1993, p. 1). Simultaneously, these trends led to the strengthening of the role of the universities as educational and research centres of the new paradigm. Universities became the biggest contractors in the R&D sector.

The same tendencies took place in the Soviet Union, although with some difference because most of the R&D sector in this country was concentrated in the laboratories of the secret science towns and the Academy of Sciences research institutes. These institutions, however, could produce good scientific products but they did not produce enough good scientists and research engineers for the military industry, and they needed new research universities as a component of the updated R&D system.

In the USSR after the end of the war, the periods of increased attention to the universities chaotically co-existed with anti-university campaigns and preferences given to the branch teaching institutes. At the end of the 1950s the authorities formulated that the university sector should have been strengthened. The argumentation, however, had nothing to do with the imperatives of economic development in the post-industrial era. Universities were addressed as the most appropriate type of educational facility to accelerate regional and national development. As a result of this policy, some new universities were opened in the biggest regional centres and in specific ethnic territories.

Easier accessibility to university education for the general public did not result in its better quality in the USSR. In general, universities remained educational facilities not engaged in the advanced R&D. Most of the new universities were created just for political reasons and reflected the ambitions of regional administrations and their ability to deal with the central authorities. The universities were considered as a factor of local prestige. Such institutions did not rely on university traditions and academic ethos; they did not have any established scientific schools and authoritative leaders accepted by the scientific community.

It is worth saying that a kind of a substitution of meanings took place: most of the newly established Soviet universities while having such a label on their facades did not differ too much from numerous pedagogical institutes or teacher training colleges. Formally being called universities, de-facto they could not be considered true universities and, moreover, could not claim having an informal status as research universities. This provoked a dubious attitude to an institution called ‘a university’ in the academic community since among universities one could find absolutely different higher education establishments having the same name.

The process of organization and maturing of such new universities was difficult and painful. There were numerous cases when even two to three decades after their formal set up some of such universities lost the qualities of good teacher training colleges, which typically were bases for their establishment but did not become fair universities. The idea of university education was spoiled in the public opinion with the exception of a very narrow circle of older universities. In parallel to that, a demand for a really good university education in the country was not satisfied. At the end of the 1950s and till the end of the Soviet epoch, the share of universities in the national system of higher education did not exceed 10 %, which was four times less against technical schools.

Despite numerous problems, from the end of the 1950s, universities were repositioned as a perspective element of the R&D system. As a result of ‘de-Stalinisation’ in the years of the Nikita Khrushchev’s ‘Thaw’, the country opened its doors to international experience with the universities claiming a leading role in R&D establishment. Some efforts to mobilize the higher school potential for research were undertaken in Russia. They were reasoned by the fact that many qualified personnel with advanced academic degrees were concentrated in the educational facilities and they did not practically participate in scientific activity. This was a huge reserve for raising the efficiency of R&D as a whole, and this fact could not be ignored any more.

The expansion of higher school participation in R&D was proclaimed as an instrument for the acceleration of technological progress in the country. It became the credo of the official science and educational politics. After 1956 new segments of university R&D infrastructure, so called ‘Problem’ and ‘Branch’ laboratories, appeared in the educational facilities. A new push received a limited number of research institutes operating under the university umbrella.

Meanwhile, neither the fundamental matrix of the anti-innovative Soviet economy, nor the whole system of the organization of science and higher education changed in the country. They remained as created already in the 1930s. In addition to that, in the second half of the 1970s Soviet higher schools experienced negative consequences of the state policy of making ‘savings’ on science and education. As previously most of the state investments in R&D were directed to the institutes of the USSR Academy of Sciences and branch institutes but not to the university system which started to decline (Vodichev 2012, pp. 263–325).

However, in parallel after the end of the World War II, a new segment in the university system appeared and developed. Socio-economic transformations in Russia and the beginning of the Cold War showed up the inability of the traditional universities to cope with the new technological challenges. This innovation, which is known as the ‘PhysTech’ model, was connected with the new paradigm of professional training for research and engineering in the advanced branches of industry.

Originally the PhysTech system in some important details was thought out as an alternative to the Soviet educational concept. The father of the system, a renowned physicist and Noble Prize winner Peter Kapitsa, who had extensive international experience, believed that it would make the Soviet education system closer to Western models and greatly raise its quality. The new model was to be utilised in an educational institution of a new type that had never existed before in the country. According to Kapitsa, a new institution of higher education should receive a high level of academic autonomy and be managed by a council of directors of those research institutes that would form a basis for the new research and educational facility.

From a historical retrospective it is now clear that the new system did stimulate the emergence of a research sector in the Soviet system of higher education. The new model was aimed at educating an elite of scientists and research engineers for fundamental and military oriented R&D and high-tech industries. Teaching was to be provided by researchers from the advanced research laboratories, presumably belonging to the Academy of Sciences system, supplemented by practical research to be done by students in the research laboratories of the academic institutes and high-tech enterprises. All curricula were to be individually adjusted depending on a narrow specialization and each student after 2–3 years of training had to participate in R&D; it was a must for everybody as an element of training. A good combination of theory and practice had to establish a background of teaching programmes and curricula.

The institutional history of the PhysTech model began when a governmental decree on the training of personnel ‘for the most important fields of the modern physics’ was issued in the USSR on 25 November 1946 (Karlov 2006, pp. 16–19). Obviously this was directly connected to the work on the Atomic bomb. Initially, a special Faculty of Technical Physics was created at Moscow State University where the system was supposed to be practically tested. However, implanting of such an entity with a special status, specific functions and an innovative educational concept caused serious problems for the University as a whole. As a result, a new educational facility was established in 1951 that received the name of the Moscow Physics Technical Institute (MPhTI). This institute became the first test site where the new model was used and further developed.

In the 1950s the PhysTech system expanded into other technological institutes, mostly those operating in the military sector of science and education. Specifically, the model was transferred to the branches of MPhTI, which were established in many ‘secret science towns in Russia’. The next step forward was made with the opening in 1959 of a new university located in Siberian Academy town, Akademgorodok, near Novosibirsk as part of the Siberian Branch of the USSR Academy of Sciences set up in 1957 (now Siberian Branch of the Russian Academy of Sciences, SB RAS).

Novosibirsk State University (NSU) had some specific features that made it one of the leading Russian universities right from its establishment. The University was already designed at the concept formulation stage as a component of the huge and multidisciplinary research centre planned to be an alternative to the central Russian research institutes. It received a special system of selection of gifted students on the basis of regional and nation-wide competitions. A special Physics and Mathematics School, a College for future university students strongly focused on maths, physics and natural sciences was established as an affiliate of the University. All NSU lecturers and professors were selected and contracted in the research laboratories of Akademgorodok’s institutes. They remained active researchers combining research and teaching. Individual curricula and early professional specialization of students were introduced, and R&D became a must for NSU students in the research institute laboratories; all were planned as part of institutional operation.

Contrary to MPhTI, a technological university, the PhysTech system at NSU was adapted to the needs of a classical university but with a wider range of specializations. The profile of the complex research centre, which was an umbrella institution for NSU, opened a door for a multidisciplinary approach to education going beyond traditional curricula of the other classical universities in Russia. This was determined by the fact that NSU was set up as a ‘function’ of the new academic centre, and its mission, objectives and purposes were formulated depending on SB RAS development strategy (Dobretsov 2007, pp. 202–212).

In the second half of the twentieth century the two educational facilities where the PhysTech educational model was originally tested, utilized and developed, MPhTI and NSU, received a high profile inside the country and beyond. Informally they were considered as leaders among the very limited number of research universities, although from a formal standpoint there was no such category of educational institutions in the USSR.

11.4 University Reform in Russia and Challenges of the Post-Soviet Epoch

Russia inherited huge R&D and higher education systems from the Soviet epoch. However, the nation's potential was substantially limited by the ineffective institutional set up with a dividing line drawn between the two sectors. The PhysTech educational paradigm remained an exception but was not widespread in the country. The system was also drastically affected by the structural crisis on the eve and after the collapse of the USSR in 1991.

In the beginning of the 1990s more then 90 % of Russian R&D institutions and higher education establishments fully depended on the state budget. In the situation of crisis when budgetary sources shrunk, financing of such institutions sharply decreased. In addition to that, in the initial stage of the Post-Soviet transformation in Russia there was an opinion shared by some representatives of the political elite that there had been 'too much of science and higher education' in the country. At that time, despite political declarations from the top level of Russian politics such as Presidential Decree No 426 of 27 April 1992 'On Urgent Measures for Preservation of Science and Technological Potential Of the Russian Federation' (Collection of Laws 1992) science and higher education were practically excluded from the system of state priorities and the accents were placed instead on stabilizing the financial system and reformation of economic mechanisms.

For some years after 1991 the share of state funding for higher education was constantly diminishing. As a result, in the period between 1990 and 1996, the number of university personnel engaged in R&D was reduced by 2.2 times (Dobretsov 2007, p. 324). Many universities and other educational institutions had to close their doctoral programmes. There was an evident threat of disintegration of the university sector in the country. This did not happen, however, and the system demonstrated a surprising degree of self-stabilization.

Gradually the situation started to change. The logic of post-communist transformation in the higher education of Russia rejected an administrative and heavily centralized model in educational management and exhibited a way of transfer to a new educational policy where state and regional interests began to be harmonized. A new education law heralded the start of this reform in 1992, which formulated a conceptual platform to an updated university policy (On Education 1992). In subsequent years the education bill received many amendments and supplements. The law was very liberal in nature. It laid down a background for the distribution of responsibilities and competences in the sphere of education between the government of Russia, regional authorities and educational establishments. Regionalization in higher education became the dominant imperative, including a possibility to create non-state (municipal, corporate, private) educational institutions. It opened wide perspectives to the regional administrations in the sphere of education that they did not possess in the Soviet epoch. In 1996 this Law was supplemented by another regulation that was focused directly on the system of higher professional education (Federal Law on Higher Education 1996). This law stipulates basic principles of state policy in the sphere of professional education at the higher level, proclaiming principles of autonomy for higher-education institutions and their academic freedoms. These two acts continue to regulate the system of higher education in Russia.

Since the middle of the 1990s, having received more liberty from the state, the system of higher education in Russia has mushroomed. In 2010 there were 1429 institutions of different kinds including 383 universities, 221 academies and 825 institutes, among which were 755 state and 674 private institutions. Great quantity, however, does not always mean good quality. The QS-THES ranking system, an annual publication of university rankings around the world, published by 'The Times Higher Education Supplement' (THES) and Quacquarelli Symonds (QS), specifies modest results for Russia. Only Moscow and St Petersburg universities have been more or less regularly included in the list of the 200 leading universities of the world. Among 500 universities just three more Russian universities are mentioned: Novosibirsk (NSU), Kazan and Tomsk.

One of the markers for effective innovation leadership is the ability to set up and maintain research universities. As mentioned above, this sector did not receive substantial development in the Soviet Union with the exception of a small segment connected with military and fundamental research and based on the PhysTech model. Recently the situation has started to improve. At the moment the major accents in Russian university policy are oriented to accelerated development of this particular sector. A new phase of reform in the national system of higher education is now underway. In particular, this is articulated by the setting up of new kinds of R&D and higher education institutions—the so-called Federal Universities (FU) and National Research Universities (NRU). The current logic of reform is based on a proper consideration of international development strategies in the sphere of higher education connected with updating institutional background for the knowledge economy. However, as noted, this is being done with some specific differences.

11.5 Federal Universities and National Research Universities

The issue of reforming the university system in Russia and 'formatting' it in accordance with a global approach has become a key subject of Russian educational policy within the last 5–7 years. The discourse about the most rational models and approaches, however, started already in the 1990s with many proposals produced and discussed. Most of the legislation referring to the new university segment was drawn up through the Federal Law "On Amendments to the Regulation of Activity of the Federal Universities," released on 14 January 2009. This law touched upon both parts of the new university segments, namely FU and NRU.

According to the legislation, the FUs are to become the hubs of educational and research activity in all Russian federal districts, of which there are now eight, aimed at developing innovation products and services. Thus, they are motivated mostly by considerations of regional development and geopolitics. The current FU network embraces nine universities located in the cities of Rostov, Krasnoyarsk, Vladivostok, Arkhangelsk, Kazan, Yekaterinburg, Kaliningrad, Stavropol and Yakutsk and thus covers the whole Russian territory from the West to the East.

A larger segment of leading RF universities is now represented by the NRU. The NRU represents those universities that are to be equally effective in performing their educational and research functions and in conducting fundamental and applied R&D in a wide range of sciences. Another important criterion is a university capability in innovation: the NRU has to identify and develop specific centres of excellence. The status of the NRU and the respective 5-year budgetary financing is provided by the federal government on the basis of a nationwide competition. Support can be extended for another 5 years if the results of a university's operation are positive. There are 29 NRUs at the moment in Russia. Of them, about 50 % (13) are located in Moscow and St Petersburg. Five NRUs are now operating in Siberia (including Novosibirsk, Tomsk, Irkutsk) and they cooperate closely with the SB RAS as it possesses research centres in all these cities.

There are two more universities that received special status and charters. These are the Moscow State (Lomonosov) University and St Petersburg State University. Thus, all together there are now about 40 leading universities in Russia. Their share is currently at the level of 10 % of the total quantity of universities operating in the country, and 2.7 % of the total number of Russian higher educational establishments. It is worth mentioning that, according the Carnegie Classification (McCormick 2001), in 2000 the share of research universities in the USA was at a level of 7 % of the total number of higher education institutions. Thus, there is some correlation between the national landscapes of research universities in these two counties.

There is currently a mutual understanding between science and education experts in Russia that at the generic level the research universities should include the following as a minimum requirement: an advanced system of R&D; close links with business and integration into an innovation system; flexibility in teaching; internationalization of activities and incorporation into international scientific and educational networks; developed infrastructure; reasonable sizes; and homogeneous structure. These principles are now presented as criteria for a successful modern university belonging to the FU and NRU system.

From the formal standpoint, however, the FU and NRU operations are being monitored and estimated on the basis of indicators set up by the Russian Federation Ministry of Science and Education (On Set of Indicators 2009). At the moment these include a number of *educational parameters* (a share of MA/MS and PhD students in total, a proportion of incoming students for MA/MS and PhD programmes in total, etc.); *R&D and innovation parameters* (a share of income generated by R&D in total income of a university, a number of publications in leading scientific journals and quotation index, intellectual property issues, etc.); *HR capacity* (a share of young teachers and researchers in total number of university personnel, a share of PhD holders, etc.); *International recognition* (a share of foreign students, international research contracts, etc.); and *Financial sustainability* indicators. These indicators do not drastically differ from the evaluation parameters for research universities used in the USA or elsewhere in the Western world.

I contend that there are some clear parallels between the US and RF approaches to the research universities philosophy. Evidently, the Russian concept was designed on the basis of models and matrixes of the US research universities. On the surface, everything looks fair and evaluation indicators designed for the Russian network of NRUs do not contradict the basic assessment principles in the USA taking into consideration some Russian specifics of administration in science and higher education. They also correlate with other international efforts in the field. On this basis I believe that current Russian university policy can be interpreted as a national effort to set up a Russian version of a 'global research university'.

Similar efforts to identify and select 'flagman' universities based on government initiatives were undertaken in many other countries—Germany, Japan, China, etc. These efforts are really rich in experience and deserve a detailed analysis. However, in most of the national initiatives leading universities are selected on a competitive basis and their identification is not purely an administrative decision. The criteria of the decision-making process are usually transparent and agreed with an academic community. Winners of nationwide competitions are granted a high degree of academic autonomy and enjoy flexibility in utilization of state funding and grants. Public transparency of budgets is always required and maintained through steering committees or other instruments.

Among different levels of higher education, MS/MA and PhD levels are positioned as the focal points in the university development programmes. Leading research universities typically concentrate on training graduates with advanced academic degrees, accepting BA/BS students from other educational facilities. The proportion of incoming students is foreseen as rather high for such universities. Also there are at least two directions in the university development strategies where investments are more than favoured. These are R&D sector, which is logical for research universities, human capital, and capacity building.

If compared with the international experience, the process of identification of FUs and NRUs in Russia has some specifics. For the FU segment no competition was arranged at all. Nomination of the universities was made just using political reasons with a lack of transparency. The rules of the game remained unknown to the academic community and the general public. This provoked serious tension in the university environment since, as many experts believe, the selection was neither fair nor made on the basis of reasonable criteria. This issue is still being debated among professionals in Russia. The situation was a bit better for the NRU segment but still lacked clarity, because numerical parameters formulated by the RF Ministry of Science and Education and used for pre-selection and final identification of the winners seemed bureaucratic and did not include any results of peer reviews. As a result, there was also no consensus achieved.

In general, a number of critical issues can be referred to when assessing the current process of university reform in Russia directed on setting up a perspective sector of research universities to stimulate R&D and the innovation process at large. First of all, there is a lack of a clear programme focused on *supporting* leading universities in the true sense of the word. Different aspects of the reformation process are not closely interconnected at the conceptual level and it is not clear which role as such a university system is going to play in the national innovation system of Russia.

Secondly, the process of change is being 'inbuilt' into the existing institutional framework and procedures for university operation. The legislation is still lagging behind and there is a need to update existing laws and regulations as they are hampering and even making contradictory the reformation process.

The current transformation process is also criticized for providing insufficient funding for the winners, which do not receive them despite truly positive results. In addition, Russian FUs and NRUs as governmental entities lack flexibility in budgeting and are not able to introduce any changes into the structure of the budget lines. This substantially limits their ability to spend the grant money that they receive from government in an efficient way, taking into consideration the specifics of each particular university.

Surprisingly enough, the winners of the competition for the status of national research university do not have the possibility to finance any aspects of R&D from grant money. Having received a new status but operating within an outdated organizational set up and with a lack of clear legislation, the universities are still overloaded with educational obligations, and their professors do not have enough time to carry out research. In the meantime, they are not able to create research laboratories, hire personnel and finance research from the governmental grants they do receive.

Contrary to international practice, there is insufficient emphasis on PhD programmes and lack of post-doc opportunities. Irrespective of their status as FU and/or NRU, the universities are still oriented to a standard cycle of training. Until 2011 there was a 5–year programme oriented at training of so called 'specialists'. Now, since Russia has demonstrated its intentions to follow the Bologna process which started after signing of the Bologna Declaration by the Ministers of Education of 29 European countries and is aimed at harmonisation of the systems of higher education in the European countries, there are just BA/BS and MA/MS curricula with a decreasing number of those who continue teaching at the same university on MA/MS programmes. In this respect, FUs and NRUs do not differ too much from the rest of the higher educational establishment of Russia.

Finally, it is worth mentioning that the new status obtained by the leading cohort of the universities was not typically accompanied with any substantial change in their management practices and personnel. Such changes are very painful in Russian universities where managers tend to occupy their offices for years, if not decades. So far no stimuli exist for management mobility in the university system.

Thus, a number of risk factors can be identified for the current reform process in the university sector in Russia. They can also be summarized in two major categories. As currently understood, the reform faces at least two groups of risks and constrains. The first are the conceptual risks. The US model, which became the conceptual basis for Russian NRUs does not correlate with the Russian approach to qualifying such universities. A research university in the USA results of public consensus reached in academic and business communities. In Russia nomination of a research university is made by the government and remains formal and administrative. The second group is represented by institutional risks. The main development factor of research universities in the USA is rooted in the fact that they possess capital assets and real estates at their disposal. They also have rich endowments. In Russia 100% of research universities are governmental assets and they are limited at every step of their economic and financial policy. There is no clear legislation on FUs and NRUs in Russia. There is no clarity and transparency in understanding of mechanisms of interaction of FU and NRU, and other segments of the national innovation system. Immigration policy still limits possibilities to invite foreign professors and foreign students. Budget articles are fixed by the financial legislation. Research activity in FUs and NRUs is not stimulated by the existing legislation, etc. We may assume that these are not just temporary shortcomings of the reformation process but rather key risk factors that can undermine the whole idea of reform and leave the innovation complex of Russia ineffective.

Conclusions

Thus, estimation of the ongoing stage of university reform in Russia is rather critical at the moment. Meanwhile, the situation is neither hopeless, nor irreversible. Although some mistakes were clearly made, there are also very important positive results achieved. Many of them are not tangible and may hardly give objectively verifiable indicators and numerical parameters for measuring. However, they impact the university system, and this is really important.

We can assume that FU and NRU reforms stimulated competition in the whole sector of the higher education and made it more adapted to the Russian and international educational markets and the market economy as a whole. A necessity to compete for resources and formulate corporate strategies to set up benchmarks is now generally accepted by university managements and the university community, and this stimulates them to develop in a competitive environment.

The process of reform and, specifically, the federal competition for the status of NRUs stimulated different regional actors, first of all regional authorities, to reassess roles and functions to be played by the universities as the agents of regional development on their territories. This resulted in a massive incorporation of universities into territorial development strategies and stimulated their partnership building practices at the regional level.

As a result of the competition, international evaluation criteria are now much widely used in Russian universities for the consideration and evaluation of their performance. This provides leading universities with the possibility to portray themselves through these indicators, optimise their development strategies in accordance with international best practice, and put in place proper benchmarks.

The reform has also stimulated investments into human capital. Meanwhile, the change of both management and teaching staff in the universities is not an'easy-going' process. So far the university milieu in Russia typically remains conservative to any substantial transformation. Nevertheless, the university reforms in Russia are still at an early stage. A number of problems remain unsolved; new challenges appeared but some progress was achieved. There could have been much more positive outputs achieved within the course of the reforms providing that the history of the university development in Russia on the one hand and international experience on the other hand is better taken into consideration.

The logic of reform focused on stimulating development of the research universities segment in the country is truly international, and it is making the university sector of Russia closer to international best practice. However, the rationale of the reform, and its implementation so far is not fair.

References

Andreev, A. Yu. 2009. *Russian Universities in 18th—first half of 19th centuries in the context of the university history in Europe*. Moscow: Znak Publishing House (in Russian).

Chutkerashvili, E. V. 1968. *Personnel for research*. Moscow: Vysshaia Shkola (in Russian).

Decree of the President of the Russian Federation No 426 of 27/4/1992. 1992. Collection of Laws of the Russian Federation. No 18. Article 1026. Moscow (in Russian).

Dobretsov, N. L., ed. 2007. *Russian academy of sciences. Siberian Branch. Historical sketches*. Novosibirsk: Nauka. Sibirskoe Otdelenie (in Russian).

Federal Law on Higher Professional Education. 1996. Rossiyskaia Gazeta, 29. September.

Gaidar, E. T. 2005. *A long time. Russia in the World. Sketches on the economic history*. Moscow: Delo Publishing House (in Russian).

Karlov, N. V. 2006. *With the tongue of the order. PhysTech: Archival Documents. 1938–1952*. Moscow: Moscow Physics Technical Institute (State University) (in Russian).

Liss, L. F., Yu. I. Uzbekova, and E. Vodichev. 2012. Higher school under systemic transformations in the transitory epochs. Part 2. Russian and American Models. Vestnik NGU. Seriia Istoriia, Filologiia. T.1, Vypusk 8.

McCormick, A. C., ed. 2001. *The Carnegie classification of institutions of higher education*. 2000 ed. Menlo Park: The Carnegie Foundation for the Advancement of Teaching.

On Amendments to Some Laws of the Russian Federation Referring to the Regulation of Activity of the Federal Universities: The Law of the Russian Federation of 10/2/2009 18-FZ. Rossiiskaia Gazeta 13/02/2009 (in Russian).

On Education: The Law of the Russian Federation of 10/7/1992 No 3266-1. Vedomosti SND I VS RF 30 (1992) (in Russian).

On Set of Indicators. 2009. Criteria and Intervals of Assessment of Effectiveness of Implementation of the Development Programme of National Research Universities: An Order of the Ministry of Education and Science of the Russian Federation of 29/6/2009 No 276. http://www.rg.ru/2009/09/18/universitet-dok.html.

Stuart, L. W. 1993. *The cold war and American science. The military-industrial-academic complex at MIT and Stanford*. New York: Columbia University Press.

Vodichev, E. 2012. *Science in the East of the USSR under the paradigm of industrialization*. Novosibirsk: NP "GEO" Publishing House, IPGG SB RAS (in Russia, Summary in English).

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Part III
Universities and Academic Research

Chapter 12
University Societies and Clubs in Nineteenth- and Twentieth-Century Britain and Their Role in the Promotion of Research

William C. Lubenow

They welcomed me cordially, and almost immediately introduced me to a small society which then I think formed—with the exception of the well-known "Apostles"—the only thing in the nature of a speculative club or gathering in Cambridge. It had been termed to Grote Club, but we knew it by no name; indeed its small size and brief life, hardly deserved that it should have one. Still, I for one, owe it much, if only for the friends I made there, and for the incalculable advantage of my being there first introduced to keen and perfectly free discussion of fundamental principle—an experience rarer 40 years ago than many would now believe.

—John Venn (Sidgwick and Sidgwick 1906, p. 149)

12.1 Introduction

Learned societies in the universities engaged in knowledge circulation, formed intellectual networks, and established interdisciplinary relationships and intellectual fields. John Venn FRS and FSA, when he arrived in Cambridge, as the quote above indicates, noted the rarity of speculative societies for the "free discussion of fundamental principles." However, such societies soon emerged in the second half of the nineteenth century and through their promotion of research assisted in the transformation of the universities. The Tripos at Cambridge and the Honours Schools at Oxford had reshaped the universities in a different way: because of the importance of the honours examinations university, dons responded by snatching teaching from the hands of coaches in the towns and drawing it into the colleges in what has been called the "revolution of the dons" (Rothblatt 1981). In this way the universities opened one way out of the *ancien regime*.

The Triposes and the Schools, with their finely tuned classifications of candidates for honours degrees, identified talent and certified merit (Lubenow 2010, Chap. 2); they were the royal road first to college fellowships, and then to positions in the reformed professions, the church and the state. The universities, as a consequence, played an essential role in the construction of civil society. As a recent

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Regius Professor of History (Sir Michael Howard) has pointed out “the reputation of [Oxford and Cambridge] has rested as much on the diplomats, civil servants, professional men and women, and political leaders as on pure scholars and scientists” (Howard 2010, p. 6).

The political and social strengths of this very unsystematic system, alas, were accompanied by intellectual limitations. The Triposes and the Schools became ossified; they strangled dons and undergraduates emotionally and intellectually. Fenton Hort referred to the Mathematical Tripos as “Our Moloch.” Bertrand Russell’s mathematics coach went mad but none of his pupils noticed it until he was locked away. When Russell completed Part I of the Mathematical Tripos (he was seventh wrangler in 1893) he gave away his mathematics books and took Part II of the newer Moral Sciences Tripos (he finished in the first class in 1894) (Russell 1969, pp. 60–65). In speaking about the honours examinations Frederick Pollock said that, having no room for unknown gods “[w]e are more superstitious than the men of Athens.” Having worshipped these idols for two generations or less “it already seems ‘unEnglish’ to dispute the complete efficacy of the ritual” (Pollock 1906, p. 225). Even Jowett, generally unsympathetic to the idea of research and one who used all the resources at his college’s disposal to place Balliol men in powerful posts at home and in the empire, confessed that though there was “more knowledge and study industry” than formerly, there was now less originality (Jowett 1895, p. 35). John Addington Symonds said he learned little of “solid value” at Oxford where there was “an almost total defect of discipline in solid studies….[and] our minds were made less by the curriculum than by our friends.” Though he did not share T.H. Green’s political and philosophical interests, Symonds was impressed by his character. John Conington, who held the newly founded professorship of Latin language and literature, “in years of close intimacy,” directed Symonds to a life of literature “by principles of common sense and manly prosaic tastes”(Brown 1903, pp. 127–130). In speaking of the possibilities of a history school at Cambridge, George Prothero wrote to Oscar Browning:

> My objection to the Tripos is that it makes it impossible to hint at such a kind of work to students; that their time is too much occupied with collateral things to pay attention to history proper….[A] seminar on the German models is quite impossible under our conditions. We shall continue doing schoolboy exercises to the end of the chapter, unless we make room for something else, & instead of trying to breed politicians, as if that was the business of the University, not to work humbly to make historians. (Browning 1883–1886)

Venn was not alone in finding it necessary to seek ways out of the strictures of formal university structures to find intellectual and emotional liberation in research and scholarship.

Dons and undergraduates, therefore, formed learned societies within the university to promote research in forms of learning to which they were drawn. These societies were interpretative communities, sites of practice, which provided their members with those things that their colleges and their formal courses of study could not provide: comradeship, and mental as well as emotional stimulation and solidarity. This essay examines Old Mortality and The Club at Oxford and the Moral Sciences Club and the Eranus Society at Cambridge as examples of the ways in which learned societies within the university promoted research and assisted in converting Oxford and Cambridge into research institutions as well as teaching institutions.

12.2 Oxford: Old Mortality

Old Mortality at Oxford was a creature of junior members of the university, young men who did not find in the Honours Schools the intellectual stimulation they felt they needed (Monsman 1970, 1971, 1998). Old Mortality nurtured these people as they struggled to shape their individual identities as they sought places in the wider world. Such struggles turned them to new forms of knowledge. Founded in 1857, in the 10 years it existed they elected 35 members. They took their name from the gravedigger from whom Scott got the tales he used in his novel *Old Mortality* (1816). Perhaps theirs was a satirical conceit to distinguish themselves, the meritorious literary men who would gain high places from those hearty athletes who found their pleasures on the playing field and in the hunt. In any event, their long lives, their forceful writings, and their extensive travels belie any claims that they might make for themselves of feebleness of body, mind or spirit. In 1872 Courtney Ilbert, James Bryce, and Æneas Mackay took themselves to Iceland for a climbing expedition. When their return was delayed Bryce occupied himself in the study of Icelandic law and customs. In these and others ways members of Old Mortality combined the rigors of mental activity with the rigors of mountaineering.

If many members of other societies became clergymen, one of the defining characteristics of Old Mortality was its members' interest in literature and the law. In this Old Mortality fits the general trend that marked Oxford and Cambridge in the nineteenth century. In 1818–1819 52 % of those taking degrees became clergymen; 17 % became clergymen in 1897–1898. In 1819–1819 11 % went into the professions, such as teaching or government; in 1897–1898 this proportion was 53 % (Jarausch 2004, p. 375). In 1857 Algernon Grenville, who himself took Holy Orders, read extracts from Bede's *Ecclesiastical History of the English People* to Old Mortality and drew attention to the "superstitious credulity of that age & writer" (Monsman 1998, p. 43). In 1858 A.V. Dicey, in the chair, read a paper on Charles Kingsley's lectures on the Neo-Platonists in Alexandria. Dicey found Kingsley's lectures deficient in literary merit and attributed Kingsley's defects to the clericalism which "had become a part of his nature" (Monsman 1998, pp. 52–53). Another member, John Wordsworth became Bishop of Salisbury but he and Grenville seem to have been clerical exceptions. As the careers of the of Walter Pater, and John Addington Symonds show, many, if not most, of their preoccupations were literary rather than clerical.

Other members of Old Mortality took up the law. Dicey became Vinerian Professor of English Law (1882–1909) and Thomas Erskine Holland became Chichele Professor of International Law (1874–1882). Some became professors in other faculties: Thomas Hill Green became White's Professor of Moral Philosophy (1878–1882); Nettleship became Professor of Latin Literature (1878–1893); Ingram

Bywater became Regius Professor of Greek in succession to Jowett (1893–1908); William Wallace was White's Professor of Moral Philosophy in succession to Green. Some became heads of houses. Charles Lancelot Shadwell (whose "stately presence … stirred awe rather than invite close advance" (DNB 1912–1921, p. 432) became Provost of Oriel College (1905–1914); Edward Caird became Master of Balliol in succession to Jowett (1893–1907), and John McGrath became Provost of Queen's College (1878–1930). Reflecting their attachment to literary studies, Dicey, Bryce, Holland, and Bywater were founding Fellows of the British Academy.

Because of their literary preoccupations, the cultivation of taste was a central purpose of the Old Mortality's meetings. Through unfettered inquiry they promoted speculation of what their rules and regulations called "the more general questions of literature, philosophy, & science, as well as the diffusion of correct knowledge & critical appreciation of our Standard English authors" (Monsman 1998, p. 18). The society heard papers on ancient (Plato, Herodotus, Cicero) and modern (Boswell, Fichte, Montalembert) letters. T.H. Green spoke on "Political Idealism" (asserting that "human society could not be looked on as a mere machine" (Monsman 1998, p. 52). Dicey spoke on "Capital Punishment." As Dicey said about his membership, "at least half the pleasure and interest of my College life is due to the existence of Old Mortality" (Knight 1896, p. 139).

With Pater, Symonds, and Swinburne (the founding secretary who read more papers than any other) as prominent members, it was inevitable that Old Mortality's literary character should be somewhat edgy since it offered enlarged opportunities for transgressiveness as well as greater intellectual scope than other university societies. As its historian has observed, Old Mortality "paved the way for a more aesthetic and open-minded standard of masculinity" (Monsman 1998, p. 26). Pater's "speculative imagination," one member recalled, "seemed to make the lights burn blue" (Knight 1896, p. 150).

Swinburne's advanced views were clear in his 1866 *Poems and Ballads*. One of the poems, "Anactoria," is particularly vivid. "Ah that my lips were tuneless lips, but pressed/To the bruised blossom of thy scourged white breast!/Ah that my mouth for Muses' milk were fed/On that sweet blood thy sweet small wounds had bled!" (Swinburne 1866/1925:I, p. 193). Such lines offended his colleague, T.H. Green, who regarded them as a "revolt against the limits of frankness set by contemporary morality" (Richter 1962, p. 83). Swinburne received an anonymous letter threatening him with castration if he did not withdraw his book within 6 months. The writer, as Swinburne wrote to Sir Richard Burton, when "I least expected, [he] would waylay me, slip my head in a bag, and remove the obnoxious organs; he had seen his gamekeeper do it with cats" (Swinburne 1959, p. 224). On the other hand, William Hurrell Mallock described the titillating effect a conversation with Swinburne had on him:

> Of what we discussed at starting I have not the least remembrance, but before very long Swinburne was on the subject of poetry. His observations at first consisted of general criticisms. Then he began to indulge in quotations from various poems—none of them, I think, from his own; but, however this may have been, the music seemed to intoxicate him. The words began to thrill me with the spell of his own recitation of them. Here at last I realized

> the veritable genius who made the English language a new instrument for passion. Here at last was the singer for whose songs my ears were shells which murmured with such lines as I had first furtively read by the gaslight of the Brighton theatre. My own appreciation as a listener more and more encouraged him. If he began a quotation sitting, he would start from his chair to finish it. Finally he abandoned the restraints of a chair altogether. He began with gesticulating arms, to pace the room from one end to the other, reciting passage after passage, and appealing to me, who managed to keep pace with him, for applause. (Mallock 1920, p. 270)

When Tennyson died in 1892 and Gladstone had an opportunity to nominate a successor poet laureate, he considered Swinburne. Gladstone had read *Marino Faliero* in 1885 and found it a work of "great power" (Matthew 1995, p. 342). But, as Gladstone remarked to Lord Acton, "the question of the succession comes before me with very ugly features." He had his own copy of *Poems and Ballads* and asked Acton whether Swinburne had withdrawn those poems that were "both bad & terrible." In the end he could not nominate Swinburne. "The licentiousness of Swinburne differs from all others known to me in the quality of its intensity." And, using one of those great late Victorian code words, Gladstone concluded that the poet's licentiousness was so "earnest" (Gladstone 1994, p. 107, pp. 103–104). A recent writer has called *Poems and Ballads* the "hymnal of the Decadent movement" (Dorment 2012, p. 15, n. 7).

12.3 Oxford: The Club

If Old Morality was a creature of junior members that produced literary and legal leaders, another society at Oxford, simply called "The Club," was a thing of dons. Its purpose was to promote research along lines advocated by Mark Pattison (1813–1884) (Howarth 2000, pp. 627–629; Jones 2007: *passim*). Pattison, according to William Warde Fowler, the historian, ornithologist and a member of The Club, was "the only classical scholar in Oxford at the time who really understood what was meant by learning" (Fowler 1921, p. 26). In Pattison's view the university should not be merely an institution continuing the practices of the public schools, filled with now-older boys cramming for examinations in the Honours Schools. Pattison's objective was to reconstruct the university in such a way as to promote scholarship and learning. For Lewis Farnell, the Rector of Exeter College, later Vice-Chancellor and a leader of The Club, membership "gave me much social delight for it brought me into a closer intimacy with men whom it was a gain and privilege to know." But it was also pledged to establish the university as "a house of learning and science" (Farnell 1934, p. 270); its objective Farnell said

> … was mainly to maintain and develop the character of the University as a home of learning and science, for this set purpose to place the interest of the University as a whole above those of the separate Colleges; to strengthen the influence of the Professoriate; and to defuse the ideal of research throughout the College teaching staffs; to encourage new subjects of study but to keep the examination system within bounds, and to exorcise the examination spirit; to act on Academical, not on political grounds, in elections to the Council and other University bodies. (Wright 1932:II, p. 488)

In short, The Club spoke for reform from the professorial and university point of view rather than from the perspective of the tutors and the colleges.

In addition to Farnell and Fowler, other members of The Club included Bywater and Nettleship, who had been members of Old Mortality in their youth, as well as Henry Pelham (Camden Professor of Ancient History and President of Trinity College), Ray Lankester (FRS, Linacre Professor of Comparative Anatomy and Director of the Natural History Museum), John Cook Wilson (Wykeham Professor of Logic), John Alexander Stewart (White's Professor of Moral Philosophy), Arthur Samson Napier (Merton Professor of English Language and Literature), John Henry Onions, John Mowat (Curator of the Bodleian Library), Reginald Walter Macan (Reader in Greek History and Master of University College), Falconer Madan (Bodley's Librarian), Wallace Martin Lindsay (Fellow of Jesus and later Professor of Humanities at St. Andrew's University), Abel Greenidge (Lecturer in Ancient History and Law), Francis Haverfield (another Camden Professor of Ancient History), Percy Gardner (Professor of Classical Archaeology), Joseph Wright (Corpus Christi Professor of Comparative Philology in succession to Max Mϋller), Frederick Yorke Powell (Regius Professor of History), Charles Firth (also Regius Professor of History), Sidney Ball (a founder of Barnett House, a center of social and political studies at Oxford), and Arthur Evans (the excavator of Knossos).

The Club was a "combative organization" (Farnell 1934, p. 270). How combative it was is shown in a speech by Arthur Evans:

> An awakened consciousness of the wasteful dualism of our existing arrangements and of the disastrous severance of teaching from research has already produced a movement from more than one direction for the greater integration of the University and College systems. The growing need for the scientific direction of our studies has inspired an effort to restore the Faculties to the place where they occupy in other Seats of Learning. The tyranny of the present examination system and the consequent narrowing and depression of intellectual interests has been more and more realized….[F]ew indeed who know the composition of our local Congregation can be sanguine enough to imagine that any adequate scheme of University reform will be carried from within. The dead weight of vested interests and the obstructive force of a particular type of College tradition is thrown into the other scale. (Evans 1943, p. 359)

Farnell was so combative in his pursuit of reform during his first term as Vice Chancellor that other heads of houses went to Curzon, then Chancellor, to oppose the customary second term.

Sidney Ball criticized the wasteful combination of professorial duties and tutorial teaching and was particularly eager to organize teaching under Boards of Faculties rather than by individual colleges. Ball, as his work for Barnett House shows, strongly encouraged research by instituting special degrees to award original work (Ball 1923, pp. 195–196). Percy Gardner was the "Gracchus of Oxford."; he was also its Joseph Chamberlain, "who does not see why things should always go on exactly as they have been done for fifty years" (Fowler 1904, pp. 20–21). Yorke Powell's inaugural address as Regius Professor of History may not have amounted to much. As Charles Oman described it: "When we were expecting him to warm up to some eloquent thesis he suddenly slapped down the last of his scraps, observed he had no more to say, and departed" (Oman 1941, p. 205). Reginald Poole, the Keeper of the University Archives in Oxford and an early editor of the *English Historical Review*, was aware of Powell's defects. He enumerated them to Acton in 1896: "(1) an awkward and archaic style; (2) an excessive hostility to all things German, his is an exaggeration of the French point of view; (3) extreme deleteriousness in carrying out arrangements" (Acton 1896). Yet Yorke Powell was committed to a concept of scientific history and his inaugural address contained the pungent observation that Oxford had not the "proper apparatus for original research" (Oman 1941, p. 205). Similarly, Firth used his inaugural address to assert that the student of history at Oxford never acquired the "mental habits of a scholar" (Soffer 2000, p. 629). Ball and Farnell were amongst the most militant members of The Club and resigned after a disagreement over the proper course of reform leaving Firth to lead the remnant (Howarth 2000, p. 629).

It is a noteworthy feature of The Club's promotion of research within the university that its members were largely drawn from those with literary, classical, and speculative interests rather than those whose interests were in natural history. Edwin Ray Lankester was the exception to this. He was a man of great charm, a booming voice, a love of conversation, and a gregarious character. As his Romanes Lecture, *Man and Nature* (1905) shows, he had intense artistic, literary, and speculative spirit, which ranged far beyond his is professional commitment to zoology. "Man is Nature's rebel," he wrote:

> He has developed speech, the power of communicating, and above all of recording and handing on from generation to generation, his thought and knowledge. He has formed communities, built cities, and set up empires. At every step of his progress man has receded further and further from the ancient rule exercised by Nature. He has advanced so far and become so unfitted to the earlier rule, that to suppose that man can "return to Nature" is as unreasonable as to suppose that an adult can return to his mother's womb. (Lankester 1905, pp. 22–23)

Arguments against the place of natural philosophy in the university were no longer cut from theological cloth. At the end of the century these controversies turned more on the question of which university resources could be diverted to these studies. Moreover, several members of The Club with literary or speculative interests had been educated in Germany where they acquired an enthusiasm for research. Francis Haverfeld, much influenced by Mommsen, declared the spade to be "mightier than the pen: the shovel and the pick are the revealer of secrets." Arthur Sampson Napier took his first degree in chemistry at Owen's College, Manchester, and then, after taking a first class degree in natural science at Oxford, went to the University of Berlin where he took up the study of old English and philology under Julius Zupitza. Wallace Lindsey and Joseph Wright went to study in Leipzig.

12.4 Cambridge: The Moral Sciences Club

At Cambridge University the Moral Sciences Club was founded as a device to assist undergraduates in their negotiation of the new Tripos. But it was quickly hijacked by the dons. The Club was formed in a period of intellectual ferment as new studies were introduced into the university. Philosophy did not have an academic home nor had it a recognizable disciplinary form. Therefore, the Moral Sciences Club served as a haven and a host for creating and shaping a new form of knowledge (Palfrey 2002; Gibbins 2001; Pitt 1981–1982). The Club was founded on 19 October 1878 in the rooms of Alfred Caldecott at St. John's College. Caldecott (1850–1936) took first-class honors in the Moral Sciences Tripos (1880), was elected to a St. John's Fellowship, took Holy Orders and became Rector of North and South Topham, Norfolk and then became Professor of Logic and Mental Philosophy at King's College, London. He wrote, amongst other works, *English Colonialism and the Empire* (1891) (which was translated into Japanese), *The Doctrine of Divine Being in English Theology* (1892), and *The Philosophy of Religion in England and America* (1901). The title of his chair and the content of his books give some notion of the uncertain location of philosophy in the mental map of the late nineteenth century.

Initially St. John's was the stronghold of the Club. In 1883 ten of the 23 members were at St. John's, five were at King's, three at Christ's, two each at Trinity and Caius, and one each at St. Catherine's, Downing, and Emmanuel (Minutes of the Moral Sciences Club, IX.40: hereinafter cited as MSC, Min.). Trinity was its stronghold 10 years later. In 1894–1895 of the 14 members eight were from Trinity, two each from St. John's and Caius, and one each from St. Catherine's and Emmanuel (MSC, Min. IX.41). From early days the Club attracted members from abroad. Mahomed Hameed-Ullah read a paper on "Nature and the Notion of Angles" in 1883. In it he "touched on the doctrine of evolution in Classical philosophy, the nature of infinity, and a theory of political truth." (MSC, Min.IX.40). In 1887 James McKeen Cattell, from Pennsylvania, read a paper, "The Time it Takes to Think," which discussed the advantages of applying what he called 'the scientific method' to the study of the mind. (MSC, Min. IX.40). Norbert Wiener, perhaps the most distinguished member from abroad, came to Cambridge from the other Cambridge (Harvard), read papers on relativism (1913) and on the meaning of sensation (1914). Meetings of the Club made quite an impression on him. As he wrote to G.E. Moore, "among the most interesting of my experiences [in Cambridge] I found those meetings of the Moral Sciences Club with the vigorous discussions you used to lead" (MSC, Min.IX.41, Moore 1918). A noted mathematician and cybernetrician, Wiener returned to the United States and, when Harvard did not want him back, enjoyed a prominent career at the Massachusetts Institute of Technology.

The Club admitted women members in the 1890s, first as visitors, then as members, and finally as leaders after the Second World war. Miss E.E. Constance Jones, then Vice Mistress (later Mistress) of Girton, read a paper on James Ward's paper *Nature and Agnosticism* in 1899. (MSC, Min.IX. 41, Jones 1912). She was in the chair in Moore's room on 2 November 1900 when the Club recorded "its profound sense of the great loss it sustained by the death of its illustrious & revered president (Henry Sidgwick)." She also read on "Categorical Propositions and the Law of Identity" on 2 December 1910 and "The Import of Propositions" on 23 January 1914 (MSC, Min.IX. 41). In 1912–1913, 11 women were members of the Club, six from Newnham and five from Girton (MSC, Min.IX.41).

The Club's numbers increased and at the beginning of the twentieth century some members became increasingly concerned about what constituted "Moral Sciences" and the location of "philosophy" within knowledge's terrain. So, in 1916 E.H. Ely and E.G. Chatterji put forward a resolution to preserve the "technical character of the discussion" by limiting the number of people "without a philosophical grounding" (MSC, Min.IX.42, ff. 18–19).

The variety of topics addressed in papers presented in the period before the Great War is a further indication of the incoherence and uncertainty of the contents of the "Moral Sciences" and the character of "philosophy." Alfred Caldecott read on "Unconscious Cerebration" (25 October 1879). Richard Hodgson, born in Australia and died in Boston, read on Complete's "Three States and the Unknowable" (15 November 1879); Henry Sidgwick sent him to India to verify Madame Blavatsky's claim to have "opened relations with the unseen world" (Hodson's report was unfavorable). Thomas Edward Scrutton, who was later called to the Bar at the Middle Temple where he became a Bencher and Judge of the King's Bench of the High Court, read on "The Irish Land Question" (6 November 1880). Herman LeRoy (Harris), the son of a general who himself had a distinguished military career, read "Schopenhauer and Modern Pessimism" (27 November 1880). Richard Norman Lucas, the not-always-reliable secretary of the Club, read a paper on "Mill's Theory of Geom[etrical] Axioms" (18 November 1882). He became a journalist and committed suicide on the Piccadilly tube station platform (MSC, Min.IX.40). Henry Sidgwick read on "Laissez fair and Free Trade" (27 May 1887). Lowes Dickinson read on "Plotinus" (4 November 1887). In an effort, perhaps, to refine the intellectual field, James Ward read on "University Studies, especially philosophy" (25 November 1887). Roger Fry read on "Form and Function" (3 February 1888). Ralph Wedgwood, the future railway administrator, read on "The Historical Method in Economics" (4 December 1894). Sidgwick read on the "Verification of Belief" in which he showed the "futility of every attempt to reach a positive characteristic of all true belief" and "[p]roposed a triad of supplementary methods of verification on the consideration of the tendency to error" (26 February 1897). John McTaggart read on "The Hegelian Doctrine of the Trinity" and the Moral Sciences Club concluded that "God in the Hegelian system was not a person but a community of persons united by love" (26 January 1900). At a meeting at which Lytton Strachey and Leonard Woolf were guests, Moore read on "Experience and Empiricism" (30 January 1903) and Maynard Keynes read on "The Nature of Inference" (6 November 1908).

The undergraduates in the Moral Sciences Club were complicit in allowing senior members of the university to influence the Club. They elected Sidwick as their president in 1880 (MSC, Min.IX.39). G.E. Moore served a chairman of the Club (1912–1944), a position designed to give direction to the Club's discussions (MSC, Min.IX. 41). As soon as they took their degrees and gained college fellowships, figures such as Moore, G.F. Stout of St. John's (who later became Professor of Logic and Metaphysics at St.. Andrew's University and the editor of *Mind*), W.E. Johnson at King's, and C.D. Broad at Trinity increasingly dominated the Club. McTaggart was prominent in the 1880s and 1890s. Bertrand Russell came to prominence in the first decade of the twentieth century. C.P. Sanger read Russell's first paper to the Club ("Geometrical Axioms) on 9 November 1894, because Russell was in Paris to take up a diplomatic career following his grandmother's desire, and in keeping with the values of Pembroke Lodge (MSC, Min.IX.41, Pitt 1981–1982, p. 109). "My present view," Russell wrote to Sanger on 29 September 1894, "is that Euclid has the same superiority over Metageometry that Kepler has over Epicycles—both seem possible ways of accounting for the given sensations, but the former in each case is the simpler" (Russell 1992, pp. 122–123). His career in the Foreign Service turned up trumps, but what was diplomacy's loss was philosophy's gain. Russell's most active period of participation in the Club was from 1898 to 1917, but he gave an additional five papers to the Club between 1920 and 1946, the last of which when he was 94 (Pitt 1981–1982, pp. 112–113). The participation of Moore, Stout, Johnson, McTaggart, and Russell in the Moral Sciences Club marks the birth of modern philosophy.

When Russell lost his college lectureship during the 1914–1918 war for writing statements thought likely to prejudice the recruitment and discipline of His Majesty's Forces, W.E. Armstrong, the then secretary of the Club, moved that "The Moral Sciences Club much regrets the loss of Mr. Russell to Cambridge & strongly deprecates the action of those who would deprive Cambridge of the services of a most renounded [sic] philosopher because of his political views" (MSC, Min.IX.42, f. 5). Moore was in the chair on 16 February 1917 when Russell returned to read his paper "On Scientific Method in Philosophy"; as the Minutes put it, McTaggart, who was one of Russell's principal antagonists on the Trinity College Council, "Was not there!"

> … the reception of Mr. Russell suggests that while the members of the Trinity Council [incidentally?] dealt a blow to the progress of philosophy at least in Cambridge, they are somewhat isolated in their attitude & are viewed by many no longer with the same respect but with amazement of their narrow-minded intolerance.

A week later, by a slight majority, the last five words of the Minutes of the previous meeting were deleted and at some point the entire passage was struck out (MSC, Min.IX.42, f.5).

Moore and Wittgenstein dominated the Club in the first half of the twentieth century. Moore read papers on the "Criticism of Professor Sidgwick's Hedonism" (1898), on "Kantian Idealism" (1899), and on "Knowledge of the External World" (1911). Wittgenstein arrived in 1912; (Keynes famously remarked "god arrived on the Cambridge platform"). He gave a paper "What is philosophy?" He left Cambridge to fight with the Austrian forces during the war and to serve periods of time as a schoolmaster and as an architect. He returned as a powerful and critical force in the 1930s and 1940s, giving papers on the "Evidence for the existence of other minds" (1930) and on "How a definition [of a word] acts as a coherent action of the use of a word" (1939). When, in 1944, Moore resigned as chairman, Wittgenstein was elected in his place.

Because of the dominance of the dons and because of Wittgenstein, the Club refined its procedures to enforce greater intellectual precision. To promote discussion they established the rule that a paper should be no more than 7 Minutes long. Wittgenstein's "What is Philosophy?" lasted 4 Minutes "thus cutting the previous record of Mr. Tye by 2 min" (MSC, Min.IX.41), a record that has never been bested. They drifted away from the 7 Minutes rule (they now have a 30 Minutes rule), and Wittgenstein insisted that they come back to it when he returned to Cambridge in 1929. As might be expected of one with his temperament, Wittgenstein was never happy with the workings of the Moral Sciences Club. After returning, when he was trying to find his feet in the Moral Sciences Faculty, he wrote to Moore: "I have seen the programme of the Mor. Sc. Cl. I think it is *awful*" (Moore 1938). When he became chairman Wittgenstein thought there were some improvements because he thought the Club was "willing to discuss important points." However, even Wittgenstein could not control some moments. When Russell returned in 1946 Wittgenstein found him "most disagreeable. Glib & superficial, though, as always, *astonishing* quick. I left at 10.30 & felt exceedingly happy when I was out on the street & away from the atmosphere of the M.Sc.Cl" (Moore 1946).

The Moral Sciences Club invited distinguished guests from outside Cambridge. Sidney Webb spoke of the "Economic Basis of Trade Unionism" in 1894; Alfred and Mrs Marshall, G.P. Gooch, Nathaniel Wedd, and G.M. Trevelyan came to hear him (MSC, Min.IX.40). J.B.S. Haldane spoke on "Hegel and the Psychologists" in 1895 (MSC, Min.IX.41). Bernard Bosanquet came over from Oxford in 1896 to speak on "Time" before 56 people. (MSC, Min.IX.41); he returned several times and in 1914 spoke on "Logical Mathematics." After the paper "the Hon. Bertrand Russell spoke at some length & after him Mr. McTaggart & Mr. Johnson" (MSC, Min.IX.41). T.S. Eliot spoke on the "Relativity of Moral Judgment" in 1915 (MSC, Min.IX.41, f. 181). Isaiah Berlin spoke on "Solipsism" in 1940 (MSC, Min.IX.43, f. 107); he returned in 1954 to read a paper in which he said that "history is empirical but not inductive; scientists work by connecting a particular proposition with general laws; this can only be done in history by distorting facts to fit theories" (MSC, Min.IX.45, f.83).

Famously, Karl Popper came to the Club on 26 October 1946. With Wittgenstein in the chair Popper attacked Cambridge philosophy as Wittgenstein and his acolytes practiced it. In a paper called "Methods of Philosophy" he asserted that Cambridge philosophy only "occupies itself with preliminaries." It claimed an "exclusiveness to the title 'philosophy' and never goes beyond those 'preliminaries' to the more important problems of philosophy" (MSC, Min.IX.44, f. 145v). And then Wittgenstein attacked Popper with a poker (Edmonds and Eidinow 2001: *passim*). As the Minutes record, "[t]he meeting was charged to an unusual extent with a spirit of controversy" (MSC, Min.IX.44, F. 145v).

Wittgenstein returned to the Club at its next meeting to answer Popper's charges. As he argued, "[i]investigating the uses of words, which is only a small part of what is attempted here, is not carried out for any linguistic purpose, as shown by the fact that the description of the use is given to those who already know what the word means, rather these uses of a word are discussed as characteristics of the concepts for which the word stands" (MSC, Min.IX. 44, ff. 146v-147). Outsiders recognized something cult-like in the relations between Wittgenstein and his followers. As Isaiah Berlin noted in 1951 after Wittgenstein's death:

> The Wittgenstein intimates—Miss Anscombe, her husband Geach, and others—were thinking of founding a colony in order to live, think, eat, and be like Ludwig. Originally it was intended to invite L. himself, but now that he is dead they propose to establish it anyhow. A great deal of violent artificial neurosis, not washing etc. anyhow you can imagine—hideous stammering in place of articulate speech, perverted Catholicism and the other delicious attributes. (Berlin 2009, p. 229)

Popper tried to get the last word. With Wittgenstein now safely dead, he turned to the Club in 1953 with his paper "Beyond Analysis." "Analysis has done something for us," Popper admitted. "[I]t has encouraged straight-forward thinking & destroyed certain kinds of unhealthy philosophy—but otherwise it has produced only narrow-mindedness." Popper felt too much time had been spent "analyzing our instrument." Language now must be used to "discuss & understand Reality." But Popper's argument fell on deaf ears and Wittgenstein's influence was felt from beyond the grave. As the Minutes record, "[l]ittle progress was made in the discussion" (MSC, Min.IX.45, f. 24). Whatever intellectual merit might be drawn from either side of the Popper–Wittgenstein dispute, the point, which needs making here, is that Cambridge (one might almost say modern) philosophy was formed and promoted in the smoldering furnace of the Moral Sciences Club rather than in the university itself.

12.5 Cambridge: The Eranus Society

Like The Club at Oxford, the Eranus Society at Cambridge was a thing of the dons. There was some dispute among early members as to the role of religion in its foundation. Henry Jackson told McTaggart "the first meetings were held in [Joseph Barber] Lightfoot's rooms and the papers were chiefly theological" (Eranus Society Minute Book/ESMB, REC.58.1, f.4). On the other hand, Henry Sidgwick said it was "not designed to be, nor has been, especially theological" (Acton 1895). Yet, with Brooke Foss Westcott and Lightfoot (both future bishops of Durham) as founding members and, given the temper of the times, the role of religion in intellectual life could not help be but one of the questions with which the Society was concerned. Indeed, Sidgwick himself took advantage of one of the meetings to attempt to draw out Lightfoot's views of the relations of religion to science. Joseph Barber Lightfoot, as James Stuart (Professor of Applied Mechanism) put it, was "very wily." He was taciturn in meetings and when he spoke his statements were very vague on the subject of science. Lightfoot put off reading a paper until all other members had preceded him and then he finally proposed to give one. Sidgwick, "gleeful and expectant," said to Stuart, "We'll have him now." After taking tea, Lightfoot led the members of the Society to another room, opened a drawer, took out a manuscript and said:

> I have been a good deal disturbed at my work during the past week, and have not been able to write the essay I hoped, but, in lieu of it, I will read you an essay I wrote some time ago on the character of Edward I.

Stuart wrote: "Sidgwick's jaw fell, as they say, and I suppose he gave up all hope of eliciting Lightfoot's opinions" (Stuart 1911, pp. 195–196).

Like the Moral Sciences Club, the Eranus Society was founded at the time of great intellectual ferment and its purpose was to give its members opportunities to explore new regimes of study. As Sidgwick put it to Acton, "[i]ts fundamental idea was to include students of various lines to afford them regular opportunities for a more serious and methodological exchange than ordinary social gatherings allow" (Acton 1895). Westcott described the Society's purpose to a prospective member:

> It has appeared to several resident members of the University who are actively engaged in different departments of academic work, that it would be a great advantage to have opportunities of meeting to consider questions of common interest in the light of their special studies. It is proposed, therefore, to form a small society for the purpose of hearing and discussing essays prepared by the members. (Westcott 1903:I, p. 385)

The Eranus Society was one of those communities of practice that attempted to find some kind of intellectual coherence and to make research more important in the university.

Consisting of ten members at any one time, the Eranus Society met on Tuesday five times a year in the rooms or the house of one of its members. In addition to Westcott, Lightfoot, Sidgwick and Stuart, its early members included Edward Byles Cowell (FBA and Professor of Sanskrit), Michael Foster (FRS and Professor of Physiology), James Clerk Maxwell (FRS and Cavendish Professor of Experimental Physics). Henry Jackson (FBA, OM, and Regius Professor of Greek), Karl Pearson (FRS, Fellow of King's College, who became Professor of Eugenics at the University of London), John Venn (FRS, FSA, Fellow of Gonville and Caius College, and an early promoter of the Moral Sciences Tripos), John Robert Seeley (the author of *Ecce Homo* and Regius Professor of History), and Coutts Trotter (Fellow of Trinity and college lecturer in physics). Arthur Westcott, in the biography of his father, indicates that George Gabriel Stokes (the first and last person since Newton to be Lucasian Professor of Mathematics, President of the Royal Society, and MP for Cambridge University), and Vincent Stanton (Ely and Regius Professor of Divinity) were also early members. The range and variety of the branches of knowledge these members studied reveal the looseness of the map of knowledge at the end of the nineteenth century and also the interest of these members in intellectual boundary crossing.

In the period from 1896 until the end of the Great War, Sidgwick, Jackson, and Vincent continued. They were joined by Lord Acton (Regius Professor of History), Edgar Adrian (PRS, OM, and Chancellor of the University), Thomas Allbutt (FRS and Professor of Physics), William Bateson (FRS, pioneer in genetics and Professor of Biology), Edward Granville Browne (FBA and Adams Professor of Arabic), Stanley Arthur Cooke (FBA and Regius Professor of Hebrew), George Gordon Coulton (FBA and Fellow of St. John's College), William Cunningham (FBA, economic historian, and Vicar of Great St. Mary's), George Darwin (FRS, son of Charles Darwin and Plumian Professor of Astronomy and Experimental Philosophy), H.A. Holland (Fellow of Trinity and a student of English law), Montague James (FBA, OM, and Provost of both King's College and Eton), Maynard Keynes (FBA and no more need be said), Alexander McAlister (FRS and Professor of Anatomy), John McTaggart (FBA and Fellow of Trinity College), F.W. Maitland (FBA and Downing Professor of the Laws of England), Reginald Crundall Punnett (FRS and Arthur Balfour Professor Genetics), Alfred Everett Shipley (FRS, Reader in Zoology, and Master of Christ's College), James Ward (FBA and Professor of Mental Philosophy and Logic), and William Cecil Dampier Whetham (FRS and Demonstrator of Experiences Physics). Of these, Allbutt, Darwin, Shipley, and Whetham were knighted (Bateson refused a Knighthood). Acton, Keynes, and Adrian were raised to the peerage. In all, it was a mighty group: Fellows of the Royal Society, Fellows of the British Academy, professors in the University, and members of the Order of Merit.

Whatever might be said about the importance of religious questions in the early history of the Eranus Society, Westcott's first paper was on "Knowledge"(Westcott 1903:I, p. 384). Arthur Balfour, apparently as a guest, read a paper in Hort's rooms on "Contradiction in the Automatic Theory of Knowledge" in 1877. Fenton Hort himself read a paper at another meeting on geological "Uniformity" (Hort 1896:II, p. 184). In 1873 James Clerk Maxwell read a paper asking whether "the progress of physical science tend[ed] to give advantage to the opinion of necessity (or determinism) over the contingency of events and freedom of the will." It contained a brave conclusion with grave implications:

> [T]hose uniformities which we observe in our experiments with quantities of matter containing millions and millions of molecules are uniformities of the same kind as those explained by Laplace and wondered at by Buckle, raising from the slumping together of multitudes of cases each of which is by no means uniform with the others. (Clerk Maxwell 1995, pp. 814–819)

In 1895 Lord Acton read his "Notes on Archival Research" in which he drew the rather triumphalist conclusion that by turning from books to archives "we exchange doubt for certainty, and become our own masters. We explore a new heaven and a new earth, and at each step forward the world moves with us" (McElrath et al. 1970, p. 140). Henry Jackson described two meetings in the Michaelmas Term, 1901 to Acton; at one Vincent Stanton read a paper on the early Christian era. Jackson himself read a paper about "the difficulty of telling & hearing the truth"; his paper, he said, "was originally planned in the hope that I should set you historians talking about such things" (Acton 1901; ESMB, REC.58.1: f. 23).

There were other notable papers in the period before the Great War: Bateson on "Modern Views of Heredity"; Maitland on "Trust and Corporations"; Edward Granville Browne on "Classical Arabic"; McAlister "On the Wisdom of the Egyptians"; Browne on "Some Persian Heretics"; Stanton on "Scientific History"; Cunningham on "Impartiality in History"; Montague James on "Greek in England in the Middle Ages"; Whetham on "Electricity, Positive and Negative"; McAlister on "Some Problems of Nerve and Muscle"; James Ward on "Some Problems of Heredity"; McTaggart on "The American Substitute for Triposes"; Shipley on "The Exploration of the Depths of the Ocean"; Keynes on "Population"; and McAlister on "Hormones".

After the Great War Coulton read on "Village Life in the 14th Century," "The Inquisition," and "The Model Monastery." Adrian read on "Hysteria," "The Middle

Brain," "Anger," and, in 1952, on "Fashions in Psychiatry." F.L. Lucas read on "The Poetry of a Don (Clough)," "The Poetry of Prose (Crabbe)," "Criticism," and "Proust." Littlewood read on "The Foundations of Geometry," "Prime Numbers," and "Infinite Numbers." S.A. Cook read on "Biblical Criticism," and "The Theory of Religion." In 1952 Boys Smith read on "Belief." C.P. Snow read on "Extroverts and Introverts," "The Novel (1922–1937)," and "The Nature of Viruses." In 1956 Hinsley read on "Violence in Contemporary Politics" and, in 1970, on "Nationalism." As this hurried survey of the papers shows, the Eranus Society was not marked by a sharp breach between scientific and religious subjects nor was there, as Snow's papers illustrate, "two cultures" in the Eranus Society (Ortolano 2009).

Edgar Adrian was a dominant figure in the Eranus Society after the Great War. He wished to resign in 1953 because of his duties as President of the Royal Society; the other members prevailed upon him to stay on and absolved him of the requirements to attend meetings and to give papers. He became an Ordinary Member again in 1966 (ESMB, REC.58.1: ff. 91,110). The Rev. Dr. John Boys-Smith (Master of St. John's College), F.H. Hinsley (another Master of St. John's), Moses Finlay (Master of Darwin College), J.E. Littlewood (the mathematician and Fellow of Trinity College), Gerald Shove (economist and Fellow of King's College), Sebastian Sprott (Fellow of King's College), and C.P. Snow were also eminent members. C.D. Broad (FBA and Knightsbridge professor) was the most eminent. He was elected to the Society in 1920 and, on the death of McTaggart in 1925, became secretary, in which post he served until 1963. During the time he was a member Broad attended 207 of 215 meetings and read 21 papers (ESMB, REC.58.1, 121).

Meetings ceased when the Second World War began and in 1948 C.D. Broad wrote to Edgar Adrian and other members:

> My own feeling is that the society should continue. Looking back, I had the impression that we had very many interesting papers and discussions, and that there were few which one would be willing to miss. If it had ever been desirable to have a society in which experts in various subjects tried to explain to each other topics in their own special fields, it is hardly become less desirable (though the practical difficulties may have increased) with the growth of specialization. (ESMB, REC.58.1: ff. 81–83)

The Society met on 4 December 1948 in Broad's rooms, which were Isaac Newton's in his time, and decided to continue (ESMB, REC.58.1: f. 4).

Conclusion

Oxford and Cambridge universities transformed themselves in the nineteenth century. They achieved this through the gradual abolition of clerical celibacy, the gradual abolition of the requirement of subscription to the 39 Articles, the gradual admission of new studies to the honours examinations, and eventually admission of women. Most tellingly, revolutionary dons, such as Sidgwick and Jackson at Cambridge, and John Cook Wilson and Arthur Samson Napier at Oxford, took the teaching of undergraduates from coaches in the towns and brought it into the colleges. The universities thus reformed became powerful centers for the training of young men for service in the world. Even so reformed, the university had a lingering defect. The honours examinations enabled successful candidates to hurl themselves though the tricks and games of the Triposes and Schools but they did little to stimulate curiosity, imagination, and originality. Sidgwick, Jackson, Oman, and Haverfield were accomplished scholars, but the universities and even their colleges did little to promote their scholarship. Prothero, G.H. Hardy, Mark Pattison, and Frederick Pollock were among those in both universities who recognized the limiting effect examination systems had on intellectual life. University reform converted the universities into institutions that twentieth-century eyes might recognize. However, there was a certain hollowness to them. Prothero realized that historical scholarship would require something like the Institute of Historical Research. H.J.S. Smith and Hardy realized that mathematical scholarship required the London Mathematical Society.

In the meantime, learned societies in the universities filled the void and became intellectual niches for the promotion of research. It was through these intellectual networks that knowledge fields were formed, circulated and assessed. Old Mortality and the Moral Sciences Club served this function for undergraduates and for the dons who wished to pursue serious learning in letters and what we might call philosophy. The Club at Oxford and the Eranus Society at Cambridge filled a similar void for dons.

These societies had a number of features: their memberships were often overlapping, heterogeneous, and multigenerational. Consequently, they shaped personal associations of shared assumptions and values. Therefore, the general who captured the garrisons at Sindh could simply report to the War Office: *Peccavi*. When A.E.H. Love took up the professorship of Natural Philosophy at Oxford and announced himself as “Love” in his senior common room he could not have been surprised by the response: “Eros” or “Agape?” Members of university societies created and shaped face-to-face knowledge. These forms of knowledge did not quite fit the frames of twentieth-century disciplines. The very name of the Moral Sciences Club reveals an instability in the kind of knowledge its members were forming. The controversy between Wittgenstein and Popper is only a dramatic remainder of its instability. The forms of learning pursued by the members of The Club at Oxford and the Eranus Society at Cambridge were only the beginnings of certain disciplines as they came to be known in the twentieth century. These were societies in which the discussion of intellectual questions in fact helped shape those disciplines and encouraged research. These societies created different opportunities for different associations, and members of university societies formed habits of sociability, which, when they went out from the university, promoted the reorganization of knowledge in the Metaphysical Society, the Synthetic Society, the Royal Society, and the British Academy. Within the university they supplemented formal arrangements at a time when the universities were reforming themselves, creating new forms of knowledge and new forms of academic organization. In the wreckage of the old, learned societies in the universities were agencies of repair and lubricated change in highly decentralized institutions.

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References

Acton, Lord. 1895. Acton Papers, Cambridge University Library, Add. 8119(5)S95.
Acton, Lord. 1896. Acton Papers, Cambridge University Library, Add. 6443[219].
Acton, Lord. 1901. Acton Papers, Cambridge University Library, Add. 8119(3)J7/7/.
Ball, Sidney. 1923. *Sidney Ball: Memories and impressions of an "Ideal Don",* ed. Oona Howard Ball. Oxford: Blackwell.
Berlin, Isaiah. 2009. *Enlightening: Letters, 1946–1960,* eds. Henry Hardy and Jennifer Holmes (with the assistance of Serena Moore). London: Chatto & Windus.
Brown, Horatio. 1903. *John Addington Symonds, A biography, compiled from his papers and correspondence*. 2nd ed. London: Smith Elder.
Browning, Oscar. 1883–1886. Oscar browning papers, King's college. Cambridge, OB.1318A.
Clerk Maxwell, James. 1995. *The scientific papers of James Clerk Maxwell,* ed. P. M. Harman. Cambridge: Cambridge University Press.
Dorment, Richard. 2012. Beautiful, Aesthetic, Erotic. *New York Review of Books,* 23. February.
Edmonds, David, and John Eidinow. 2001. *Wittgenstein's Poker: The story of a ten-minute argument between two great philosophers*. New York: HarperCollins.
Eranus Society Minute Book (ESMB), Trinity College, Cambridge, REC.58.1.
Evans, Joan. 1943. *Arthur Evans and his forbearers*. London: Longmans.
Farnell, Lewis. 1934. *An Oxonian looks back*. London: Martin Hopkinson, Ltd.
Fowler, William Warde. 1904. *An Oxford correspondence of 1903*. Oxford: Blackwell.
Fowler, William Warde. 1921. *Reminiscences*. Oxford (printed for private circulation).
Gibbins, John R. 2001. Constructing knowledge in Mid-Victorian Cambridge: The moral sciences tripos. In *Teaching and learning in nineteenth-century Cambridge,* eds. Jonathan Smith and Christopher Stray, 1850–1870. Woodbridge: Boydell Press.
Gladstone, W. E. 1994. *The Gladstone diaries with cabinet minutes and prime-ministerial correspondence, Volume XIII, 1862–1896*. Oxford: Clarendon Press.
Howard, Michael. 2010. [Letter] to the editor of the *Times literary supplement,* 29 January.
Howarth, Janet. 2000. The self-governing university, 1882–1914. In *The history of the University of Oxford, Volume VII, nineteenth-century Oxford, Part 2,* eds. M. G. Brock and M. C. Curthoys, 599–644. Oxford: Clarendon Press.
Jarausch, Konrad. 2004. Graduations and careers. In *A history of the University in Europe: Volume III, Universities in the nineteenth and early twentieth centuries (1800–1945),* ed. Walter Rüeff, 363–389. Cambridge: Cambridge University Press.
Jones, E. E. Constance. 1912. *As i remember: An autobiographical ramble.* London: A.C. Black.
Jones, H. S. 2007. *Intellect and character: Mark Pattison and the invention of the don.* Cambridge: Cambridge University Press.
Jowett, Benjamin. 1895. *College sermons,* ed. W. H. Fremantle. London: John Murray.
Knight, William. 1896. *Memoirs of John Nicol.* Glasgow: James MacLehose.
Lankester, E. Ray. 1905. *Nature and man*. *The Romanes lecture.* Oxford: Clarendon Press.
Lubenow, William C. 2010. *Liberal intellectuals and public culture in modern britain, 1815–1914: Making words flesh.* Woodridge: Boydell Press.
Mallock, W. H. 1920. *Memoirs of life and literature.* London: Harper and Brothers.
Matthew, H. C. G. 1995. *Gladstone, 1874–1898*. Oxford: Clarendon Press.
McElrath, Damian, James Holland, and Sue Kazman, eds. 1970. *Lord Acton: The decisive decade, 1864–1874*. Louvain: Bureau de la R.H.E., Bibliothèque de l'Université.

Monsman, Gerald. 1970. Old mortality at Oxford. *Studies in Philology* 67 (3): 359–389.
Monsman, Gerald. 1971. Pater, Hopkins and Fichte's ideal student. *South Atlantic Quarterly* 70 (3): 365–376 (Summer).
Monsman, Gerald. 1998. *Oxford University's Old Morality society: A study in Victorian romanticism,* Lewiston-Queenston-Lampeter: The Edwin Mellen Press.
Moore, G. E. 1918. G.E. Moore Papers, Cambridge University Library, Add. 8330/8W/22/1.
Moore, G. E. 1938. G.E. Moore Papers, Cambridge University Library, Add. 8330/8W/32/47
Moore, G. E. 1946. G.E. Moore Papers, Cambridge University Library, Add. 8330/8W/32/65
Moral Sciences Club (MSC) Minutes, Cambridge University Archives, Min.IX.39–45.
Oman, Charles. 1941. *Memories of Victorian Oxford and of some early years.* London: Methuen.
Ortolano, Guy. 2009. *The two cultures controversy: Science, literature, and cultural politics in postwar Britain.* Cambridge: Cambridge University Press.
Palfrey, David. 2002. *The Moral Sciences Tripos at Cambridge University, 1848–1860*. Cambridge University, Ph.D. Dissertation.
Pitt, Jack. 1981–1982. Bertrand Russell and the Cambridge moral sciences club. *Russell: The journal of the Russell archives* (new series) 1 (2): 103–118 (Winter).
Pollock, Sir Frederick. 1906. *Oxford lectures and other discourses.* London: Macmillan.
Richter, Melvin. 1962. *The politics of conscience: T.H. Green and his age.* London: Weidenfeld and Nicholson.
Rothblatt, Sheldon. 1981. *The revolution of the dons.* Cambridge: Cambridge University Press.
Russell, Bertrand. 1969. *Portraits from memory.* New York: Simon and Schuster.
Russell, Bertrand. 1992. *The selected letters of Bertrand Russell, Volume I: The private years, 1884–1914,* ed. Nicholas Griffin. London: Allen Lane.
Scott, Sir Walter. 1816. *Old mortality.* 2 vols. Westminster: Archibald Constable, [1895].
Sidgwick, A. E., and E. M. S. Sidgwick. 1906. *Henry Sidgwick: A memoir.* London: Macmillan.
Soffer, Reba. 2000. Modern history. In *The history of the University of Oxford, Volume VII, Nineteenth-century Oxford, Part 2,* eds. M. G. Brock and M. C. Curthoys, 361–384. Oxford: Clarendon Press.
Stuart, James. 1911. *Reminiscences.* London: (printed for private circulation) Chiswick Press
Swinburne, Algernon. 1866. Poems and Ballads. In *The complete works of Algernon Charles Swinburne,* 1925, eds. Edmund Gosse and Thomas James Wise. New York: Russell and Russell.
Swinburne, Algernon. 1959. *The Swinburne letters, Volume I: 1864–1869,* ed. Cecil Y. Lang. New Haven: Yale University Press.
Ward, James. 1899. *Nature and agnosticis.* (unpublished).
Westcott, Arthur. 1903. *Life and letters of Brooke Foss Westcott, D.D., D.C.L., Sometime Bishop of Durham*. Vols. 1 & 2. London: Macmillan and Son.
Wright, Elizabeth Mary. 1932. *The life of Joseph Wright*. Vols. 1 & 2. London: Oxford University Press.

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Chapter 13
The German Model of Laboratory Science and the European Periphery (1860–1914)

Geert Vanpaemel

In the 1860s French scientists sounded the alarm over what they considered to be the deplorable state of science in their country. In speeches, papers and letters they voiced their concern over the lack of opportunities for scientific careers or the decrepit state of laboratories and university buildings (Fox 1973, 1990). Scientific work was not appreciated as it should be, and scientific institutions were severely underfunded (Fauque 2005). France was lagging behind the development of science in other countries, notably in the much-admired Germany. As Louis Pasteur (1868) wrote:

> Since thirty years, Germany has been covered by spacious and richly [provided] laboratories, and every day we see new ones being created. In Berlin and Bonn two palaces worth 4 million [francs], both destined to chemical research, are being constructed. Saint-Petersburg has devoted 3 million to [the building of] a physiological institute. England, America, Austria and Bavaria have made the most generous sacrifices. Under the ministry of Mr. Matteucci, Italy has walked for a moment in their footsteps. And France? France has not yet begun to undertake this work.

This period has often been interpreted as a sign of decline of French science, but whether there really was a decline is still a matter of debate among historians (Ben-David 1969; Paul 1972). Although it is generally conceded that Germany was outperforming the other European nations in scientific and technological research, this observation is not sufficient to conclude that the other nations were going through a phase of decline. In general it is very hard to define objective measures by which a decline can be measured, and the concept itself may turn out to be problematic (Nye 1984). But in analysing the outcry of the French scientists, the issue of real or imagined decline is only of secondary importance. What matters more is the role of other nations' progress, in particular the German achievements, in pointing out the deficiencies of the French research system. This is, of course, a standard rhetorical strategy: in order to bring the government to act, one points to the backwardness of the domestic situation and the 'threats' posed by other, more enlightened or less

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parsimonious nations. No doubt, the admiration for Germany was genuine, but the view of German science presented by the French scientists was too much tailored to the needs of French science for it to be an adequate analysis of the German research system (Fox 1990). When the chemist Adolphe Wurtz was sent by the French government to visit German laboratories, he returned with a detailed description of buildings and designs but without mentioning the peculiarities of German laboratory education or the relationship between laboratory facilities and scientific output (Wurtz 1870). It is clear that the German example, as cited by the French scientists, was to a large extent a fabricated mirror image of those French problems that were deemed to be most urgent.

It comes as no surprise to historians that the self-serving arguments put forward by historical actors should be read with much cautiousness. But apart from the difficulties of reconstructing the reality behind the arguments, it is also interesting to look at the motives for actors to construct these arguments in the first place. In the French case, the ultimate rationale behind the public outcries of the 1860s was the demand for more government support and for the erection of suitable research facilities. On a second level, the reference to the recently formed state of Germany[1] touched upon patriotic feelings and the sensitivities of the political elites. The argument also put the French scientists in a favourable light. By explaining to the public (and the politicians) the very reasons why German science had progressed and French science had fallen behind, they could present themselves as knowledgeable, and thus as the privileged experts in suggesting the necessary measures to be taken.

In the last decades of the nineteenth century, many European countries adopted a laboratory science system, in which the so-called 'German model' served as the prime example to be imitated. As in the French case, the German model played many roles in this process, not in the least the one of supporting the position of the advocates for reform. What is intriguing about this European phenomenon is that there is so little convergence in the models presented by the various actors. How German science is presented can differ from one country to another, and from one era to another. Clearly, the term 'German model' had become something of a stop-cock to fit anything in the domestic system that needed reform. There was no doubt that Germany was leading the way in the organisation and management of research, but the exact definition of that way could diverge hugely. In this paper I present this persistent use of the 'German model' as a step in the formation of the centre-periphery construct. In our view the concepts of 'centre' and 'periphery' are not dichotomous but complementary, in the sense that the centre embodies the shared values of scientists both at the centre and the periphery. The centre emerges as a focal point for the aspirations fostered at the periphery. The diverging and often contrasting interpretations of the German model of laboratory science exemplify this complex and ambivalent relationship between centre and periphery.

In the first part of this paper we will examine the centre-periphery dualism as it emerges from the historical and scholarly literature. Then some of the meanings of

[1] The formal installation of the new German state occurred only in 1871, but there was an on-going process of integration, e.g., in the Zollverein, the construction of railways and cultural unity.

the German model in different contexts will be analysed. Finally, we will explore some of the meanings attached to the German model in the process of forming the centre-periphery nexus.

13.1 The Shifting Nature of Centre-Periphery Dualism

In the introduction to *L'Europe des sciences. Constitution d'un espace scientifique*, the editors Michel Blay and Efthymios Nicolaïdis explain how it was their intention to make a study of the influence of scientific knowledge on the homogenization of societies. They believe that European science as such constitutes not only a geographical category, but also an "intellectual unity": the particular knowledge created in Greek Antiquity was transformed in Europe during the Scientific Revolution, and subsequently exported towards other regions of the world. In particular for Europe, travels, translations and centre-periphery relations have all contributed to the unification of a single scientific space (Blay and Nicolaïdis 2001, pp. 9–11). But the existence or rather the creation of a unified space raises many questions. How can distant participants of a scientific community interact with each other over long distances? How do shared values arise from different local traditions? How is a 'homogenized' science constructed, received and appropriated by scientists in various contexts, and how is scientific knowledge itself affected by the processes of diffusion and adaptation?

Sociologists have used for a long time the concept of a unified world-science system. Following Braudel and Wallerstein, an understanding has grown of the characteristics of global science, its hierarchical structure and its homogeneity, but also its differentiation and segmentation. World-science is often considered merely an extension of the structural features of the local scientific community, where scientists share their ideas in exchange for recognition and emulation (Polanco 1989). But in as much as there exists a unified scientific space, there are different levels of integration, which cannot be ignored. Every scientist is part of individual, national and international communal formations, which have different ways of operating. The integration of these communal formations may depend on political, ideological or economic factors, which may destabilize the global system and lead to the 'decommunalization' of world science (Schott 1993).

What can be deduced from these studies is that the existence of a unified space necessarily presupposes the existence of one or more centres. In the centre, the values of the epistemological space are articulated and embodied. It is not necessarily linked to a geographical location. Rather, the centre is, according to Edward Shils (1961), the representation of the order of symbols, of values and beliefs, which govern the community. As such, the centre is a powerful actor that holds a community together. The centre is closely related to the notion of 'elites', and attains a formal status by virtue of institutionalization. The periphery, on the other hand, is characterized by exclusion and distance from the centre. The views of Shils were further developed with respect to the international scientific community by Rainald von Gizycki in 1973. Basing his ideas on a comparative study of nineteenth-century science in Germany, France and Great Britain, Gizycki defined the centre “by the fact that works produced there command more attention and acknowledgement than works produced elsewhere. […] the theories and observations produced there become sources of influence and objects of emulation” (Gizycki 1973, pp. 474–475). There may be different centres for different scientific disciplines, but there is a tendency for the centres to be clustered. At the same time, there is a tendency for centres to be displaced by new, emerging centres.

Gizycki’s view on scientific centres is based on competition, a race for scientific leadership. Research located at the centre of the scientific community is in all respects superior to research in peripheral regions. Countries in the periphery are countries that have lost the race, albeit only temporarily. The periphery inevitably attempts to imitate the centre or to modify its own structures to bring them closer to the models drawn from the centre. Gizycki (1973, p. 479) observed:

> A scientist who wishes to make an important contribution to science and thus to ‘make his mark’, must, if he lives and works at the periphery, conform with the standards embodied and espoused by the centre. He must know the substance of the centre’s accomplishments by reading its scientific literature; he must know the language of the centre. He is forced to live in its shadow.

In this model, the only activities granted to the periphery are imitation, adaptation and emulation of the centre. In essence, the periphery is mostly unproductive of knowledge and a passive, perhaps even a superfluous bystander of the scientific community. To understand the scientific community and the history of scientific developments, it is sufficient to look at the centre.

Recent studies have presented alternatives to this model. In global studies, students of ‘non-Western science’ have questioned the putative unity of science and its central values. As Kapil Raj noted: “In place of a unique ‘modern science’, it is now accepted that there are many national and local knowledge traditions and dynamics spread across most of North and West Europe, with diverse, and at times contradictory, intellectual agendas and influences throughout the early-modern and modern periods” (Raj 2006, p. 7) The unidirectional spread of Western Science, as modelled in the 1960s by George Basalla (1967), was not a simple emanation from a pre-existing centre, but the result of a complex process of conflict, acculturation, and appropriation. Marcos Cueto (2006) equally rejected the traditional notion of periphery as being unhelpful in understanding the dynamics of a ‘peripheral’ region’s scientific development. In Europe, the community of scholars constituting the STEP-group has also questioned the notion of periphery. In a joint paper, Kostas Gavroglu and others have pictured the periphery as an active receiver, making “a shift from the point of view of *what has been transmitted* to the view of *how, what was received has been appropriated*” (Gavroglu et al. 2008, p. 154).

To many scholars the dichotomy between centre and periphery should probably be left as a descriptive category to researchers of the present-day world science system, but without further historical or explanatory value. Yet, the centre-periphery dichotomy can be fruitful if the perspective is shifted from a competitive model towards a ‘complementarity’ model. In this model, a centre is not simply a fixed geographical location where knowledge is produced and standards are defined, but an imaginary, vaguely located place to which, by actors at the periphery, certain meanings and values are attributed. The centre is not the origin of the space around it, but is created by the projection of local ideologies on a symbolic object. This presupposes a two-way mechanism of appreciation and emulation between centre and periphery, in which both have important roles to play. Centre and periphery participate as complementary forces in the production of shared community values. The very use of the centre and periphery vocabulary may help to understand how a common identity within the community is being created and shared.

Much of the scholarly literature focuses either on the characteristics of the centre, or on the development of the peripheral region. The actual relationship between centre and periphery has been taken for granted as if it seems to follow immediately from their respective positions. In this paper I consider the centre and periphery to be mutually dependent on each other. The centre emerges when it is recognized as such by members of the community, whereas by this very act these members show themselves to adhere to commonly shared values and to be an integral part of the larger community. I maintain that the centre-periphery model should not be used to make a distinction between two geographical or cultural spaces, but rather that it can help to underscore their connection. A close analysis of the centre-periphery metaphor, used by different actors in different locations and from different perspectives, may show how these values and practices are perceived and interpreted.

13.2 Laboratory Cultures and the German Model

One example of a typical centre-periphery narrative can be found in the creation of modern laboratories at the end of the nineteenth century. In many countries, this ‘laboratory movement’ was supported by referring to the lead taken by Germany in science and industry. But the role model of Germany in this process as interpreted according to the simple competition model of Gizycki cannot explain a series of complex and ambiguous problems. First of all, there is no exact definition of what the German model was. In fact, many nineteenth-century observers stressed contrary features of this model, in order to advance their own agendas. Also, no single country in fact copied the German model, but rather produced a locally adapted form of a laboratory system. What was common, however, was the agreement between many scientists and politicians, that if a model existed, it had to be found in Germany. In as much as the ‘German model’ can be considered a construct adapted to local needs, it shows how the relations between centre and periphery may be reconsidered.[2]

[2] We restrict our research to European countries, where the use of the term ‘periphery’ refers to a different situation compared to the periphery on a global scale. Whereas European countries always felt related to the European centres, colonial and postcolonial experienced a much sharper difference with Western countries, both in size of the scientific community as in the cultural

During the second half the nineteenth century, the modern laboratory emerged as a new, important institution of science. Laboratories had existed before, and were recognized as privileged spaces for experimental work, in particular in chemistry (Crosland 2005). But the new nineteenth-century laboratories were different in scope and institutional status. In universities large laboratories were built for pedagogical reasons, instructing students in routine scientific manipulations, while providing some space for more advanced research. Somewhat later, laboratories were set up for agricultural and industrial research, transforming the nature of technical research and invention. More generally, the laboratory became an abstract institutional category of scientific practice, unconnected with a certain location or researcher, and very often referred to in the plural. This institutional role of the laboratories inspired Pasteur (1868) to describe them as "temples of the future, of wealth and well-being".

The building of laboratories was typical of the modernization era of science (1850–1950), when laboratories were considered a first and necessary step towards the implementation of scientific practices within a national culture. In university education, the laboratory underscored the rise of pure science as a basic element of intellectual culture. In government policies the evolution towards a modern, enlightened state was translated in the creation of experimental agricultural stations, food analysis laboratories and bacteriological institutes. Laboratories thus transformed many aspects of intellectual life, industrial activities and medical practices.

One of the characteristics of these laboratories was their uniformity to an international standard. This uniformity warranted access to the international scientific community and became a recognizable feature of modernization. Very often, the so-called 'German model', based on both the academic laboratories in German universities as well as on the industrial laboratories in the German dyestuff industries, was put forward as the ideal model to replicate. In particular in peripheral countries, adaptation of this German model was a strong rhetoric for discussing the necessity and the direction for reform of their own scientific culture.

What was this 'German model' about? In the historiography, there are at least three substantially different definitions that all refer to the leading example of Germany in transforming scientific research. The first definition is founded on the German university model, as forged by Wilhelm von Humboldt in the early nineteenth century. The Humboldtian University emphasized the importance of universal *Bildung* over professional expertise. Knowledge was to be pursued for its own sake. Lectures were complemented by seminars where contemporary issues and new research were discussed and where students were trained in the critical analysis of original writings. In the natural sciences, students were given the opportunity to study recent research and to acquire the specific skills of experimental research. The German university became the cradle of an intellectual elite, a model that was soon to be copied in other countries (Hannaway 1976).

distance purposely maintained by colonial powers. Also, for briefness, I will not discuss the development of the laboratory system in Germany and the internal response to the (externally constructed) German model.

The influence of this German model was felt throughout the nineteenth century, but was superseded in the second half of the century by another German innovation, the university laboratory. This innovation is often linked to Liebig's chemical laboratory class in Giessen, which became famous in the 1840s. In the next decades many German universities built "spacious and richly provided laboratories" in physics, chemistry, physiology and anatomy. It was to these laboratories that Wurtz was sent in 1868 and which represented to the French scientists the quintessence of the German model.[3] The laboratories were a combination of a student laboratory and a research laboratory for the professor and his assistants. Although the laboratories originated in the seminar system of the Humboldtian University, the emphasis shifted from universal knowledge towards specialization and technical competence. In practice, the university laboratories were powerful, almost independent institutions, which gave ample space to the laboratory director to develop his own line of research, and to enlist his students in his research program. Compared to the private or small professor's laboratories in other countries, the German laboratories were large scale and powerful institutions at the centre of academic life, crucial in the educational curriculum and highly appreciated as representations of the university.

A third definition of the German model refers to the erection of research laboratories in the chemical industry (Homburg 1992, pp. 91–111; Fox and Guagnini 1999, pp. 150–165). Although the first steps towards the industrial research laboratory were taken in France and Britain, it was in Germany that the research laboratories, set up in the dyestuff industry around the early 1870s, came to be considered as a strategic instrument for economic success. It was generally accepted (and often emphasized by German politicians and industrialists) that the true cause of Germany's economic growth lay in the excellent education of the industrial chemist and engineer, and on the willingness of the German industrialists to invest in large-scale laboratory facilities. The impact of this model became predominant at the close of the nineteenth century until the outbreak of World War I. A related version of the German model stressed the special link between industry and higher education. Universities and *Hochschüle* were not to be regarded as closed shrines of pure science, but as driving forces in the application of science to industrial progress. According to this version, universities had to adapt to the needs of an industrial society. Not very different was the fame of the German system of agricultural research stations, which combined activities of research and control, founded around the middle of the nineteenth century by the state and private stakeholders. By building a vast network of research stations, connected to the universities but reaching out into the agricultural community (including landowners and agro-industrialists), the German model was the example of many agricultural stations in the world (Jas 2000; Finlay 1988).

These definitions have in common that German science was seen as based on a well-organized and state-funded system, in which the universities have an important role to play. Also, the central position of the laboratories is reiterated in all of the definitions. On the other hand, the definitions also contain contradictory

[3] A similar initiative was taken in Britain. See Hofmann 1866.

features, e.g., in the balance between science and politics, or between pure and applied science. Observers often picked out the features that fitted their own schemes.[4] In general there was a fluid transition from the original German university ideal (definition 1) to the model of university laboratory education (definition 2) to industrial research laboratories (definition 3), but in the final decades of the nineteenth century any of these definitions could be employed. One should not forget that, apart from the praise for German laboratories, the admiration for Germany was also based more broadly on general political or cultural preferences, again often compared to the deficiencies of the domestic regime.

The role of the German model in the reform of universities and the creation of laboratory facilities has been amply studied in the cases of France and England (Hennock 1990; Haines 1958; Roderick and Stephens 1982; Paul 1972; Fox 1990). Competition between nations was a driving force in these debates, with Germany clearly considered in the lead, but the outcome was as much determined by domestic issues as it was by simple imitation of a scientific centre. As George Weisz (1983, p. 62) observed on the French debates: "It is impossible to cite more than a few concrete instances of institutional imitation […]. A highly idealized image of German universities served to symbolize a variety of goals and aspirations. The most contradictory positions were defended by appeals to the German example." And with respect to England, George Haines (1958, p. 227) wrote: "To claim in each instance [of newly founded English colleges] direct German influence would be preposterous. But the widely and continuously cited German example, the intensively fostered fear of German industrial competition, and the German experience of many of the leading teachers played important roles in providing an impulse, otherwise so long delayed as to be almost inexplicable." These cases demonstrate how the 'German model' was a malleable concept, which could be used for almost any purpose. In many instances, the laboratories and universities of Germany were only described in abstract generalization, and different aspects of the German system (support by the State, laboratory research as part of university education, emphasis on direct links with technology) were variously given as fundamental features. The German inspiration of reformers was in any case more important than any German example to be copied or imitated.

13.3 The German Model in the European Periphery

Apart from France and England, there are only a few studies on the impact of the German model in peripheral countries. References to the German model are not absent, but almost never critically analysed. A comparative analysis of the influence

[4] An example of the domestic spectacles used to magnify specific features of the German model is given by Thomas Huxley in his 1868 address to the South London Working Men's College on 'A liberal education and where to find it': "In short, in Germany, the universities are exactly what […] the English universities are not". Published in Huxley (1896, p. 107).

of the German university model (definition 1) is given by (Schwinges 2001). Along the same line there are some papers on the imitation of German organizational models in relation to scientific societies (Pancaldi 1998; Casalena 2007; Gizycki 1979). As to the creation of laboratories, one has to rely on individual cases, which are hard to come by. Kenneth Bertrams (2006) offers interesting material on the replication of German industrial research model in Belgian universities. From what can be gathered from exploratory readings, some themes for further research readily emerge. We present them in the form of questions, which befits the current state of our research. A thorough investigation of local sources will certainly lead to more interesting approaches on the construction and appropriation of the German model.

13.3.1 At What Time, and Through Which Channels, Did the German Model Actually Find its Way into 'Peripheral' Debates?

In most countries the apostles of the German model had studied for some time in Germany or were personally acquainted with German scientists. In other cases, German scientists settled in peripheral countries. In Belgium, the German chemist August Kekulé, appointed to the chair of chemistry in Ghent in 1859 introduced the German model of laboratory education (although not yet called by that name) (Gillis 1959). Similarly, the German agricultural system was brought to Belgium in 1871 by August Petermann, a student of Fresenius (Diser 2012). Other (Belgian) advocates of the German system included Louis Henry, who had spent some time in Giessen, Jean-Baptiste Carnoy, who studied in Bonn and Walthère Spring, of German descent and a student of Rudolf Clausius in Bonn (Van Tiggelen 1993). Yet, although it seems logical that a personal link to Germany or German scientists would be necessary to become an advocate of the German model, this is not necessarily the case. Ideas sometimes travelled more easily than people.

The conscious use of the 'German model' appears to have come into use only in the 1860s, that is when French and British scientists were advocating German science as a model for their domestic science system. As yet, I have not found any use of the German laboratory model in 'peripheral' countries, before it became into vogue in France and Britain. This may indicate that these countries were crucial in starting the promotion of Germany as the leading country in science. Furthermore, if the German model as such actually started as a mirror image of domestic (French or British) science, this suggests that at first the features of the German model were constructed on the basis of the deficiencies of French and British science. In other words, peripheral countries may have focused more on France and Britain than would appear from their rhetorical praise of Germany. One suggestive example can be found with the Portuguese physiologist Costa Simões who in 1865 visited universities in Germany (Bonn, Würzburg, Heidelberg, Munich, Göttingen and Berlin), France (Paris), Belgium (Brussels, Leuven, Ghent and Liège), Holland (Amsterdam, Leyden and Utrecht) and Switzerland (Zurich). On his return, he decided to organize his own laboratory in Coimbra on the example of the Berlin University but he did so only after receiving advice from different experts. The choice of these experts was indeed not confined to Germany and therefore reflected a much broader scale of scientific systems. The status of German physiology was a topic of conversation among many colleagues, not only German. Also the instruments Simões acquired for his laboratory were bought in several locations (Paris, Berlin, Liège and Vienna), which again may indicate that his actual implementation of the Berlin example was broader than a simple imitation and in some cases was only indirectly linked to the German sources (Burguete 2010). Likewise, the Lisbon physician Marck Athias became aware of the debate on German science during his studies at the Faculty of Medicine in Paris in the closing years of the nineteenth century (Amaral 2006). Athias never studied in Germany; his French background was all too visible in his 10-year career at the Pasteur Institute in Lisbon. As head of the Lisbon Institute of Physiology his work was characterized by the positivist ethos of French science, although his scientific practices were modelled on the German tradition.

Even when personal acquaintance with German science was available, the outcome was not necessarily only directed towards Germany. Early physiologists such as the Russian Ivan Mikhailovich Sechenov studied with a. o. Carl Ludwig in Vienna, Emil Du Bois-Reymond in Berlin and Claude Bernard in Paris. Although he used Du Bois-Reymond's experimental apparatus in his own laboratory, his work bears the influence of all the great physiologists with whom he worked (Kichigina 2009). Finally, the Cracow physics professor Zygmunt Wroblewski had studied in Berlin, Heidelberg and Munich but consequently made an extensive tour of other European research institutes, ending up in Paris. When he set up his laboratory at Cracow, he brought the needed apparatus from France (Kubbinga 2010). If the German model was to him a powerful rhetorical device, it cannot be assumed that it actually was the model that he wished to copy.

13.3.2 Which Values were Associated with the Articulation of the German Model?

What was the rhetorical power of the German model? Was it based on an objective evaluation of scientific output? Some examples suggest that admiration for German science was often part of a larger cluster of values. Germany was heralded for its artistic and literary culture, its national vigour (in particular after the unification of the German states in the 1860s), its industrial successes, the honours bestowed on science by the State and the general public, its victorious clash with France, etc. It has been suggested by Andrée Despy-Meyer and Didier Devriese (1993) in their study of the Belgian physiologist Paul Heger and his collaboration with Ernest Solvay in the creation of new research laboratories, that the enthusiasm for German imperial science among progressive liberals should be understood by the appeal of the anti-clerical politics of Bismarck, at a time when the earlier admiration for French positivism had been replaced by Germany's successful *Kulturkampf*. On the other hand, in France, German science was—particularly after the defeat in the Franco-Prussian war—associated with a medieval worldview, firmly held under the influence of religion (Weisz 1983). Political attitudes also played a part in the Habsburg Empire. Many German-speaking scientists integrated themselves into the German scientific community, in the hope of contributing to the ethnic German community, but non-German-speaking scientists only grudgingly accepted the domination of German-inspired institutes. In Prague the university obtained the liberty to teach in the Czech language, as Cracow did in Polish (Kernbauer 1997).

These examples suggest that the positive mention of a German model should always be interpreted against a much larger field of values associated with the German state and German culture. It becomes important therefore to carefully position the advocates of the German model in the social, cultural and political spheres of their country. It can be expected that the values associated with the German model resonated well with the cultural ideals of existing or upcoming elites. For France and England, it has been established that the outcome of the 'German reforms' supported the rising social status of bourgeois intellectuals. For peripheral countries in particular, where nationalist feelings were often very prominent, the relationship of 'German-minded' scientists with social elites and public authorities has to be examined. With regard to agriculture, local power relations and ownership of the land had great impact on the implementation of agricultural stations and laboratories. Russian agricultural stations grew from laboratories on private lands, then developed into regionally based *zemstva* stations and finally into state bureaus (Elina 2002). In this case the involvement of the Russian state in the promotion of the French Pasteur institutes appeared to have been more effective than the abstract rhetoric of the German model (Hutchinson 1985).

13.3.3 How Did the German Model Transform the National Science System?

The science system comprises all cognitive and institutional resources available to a country for its industrial and cultural development. Universities, research institutes, scientists, government agencies and industrial actors all contribute to produce knowledge and wealth. At the same time, the system itself is a distributor of values: it conveys status on important actors and authority on institutions, legitimating scientific practices while undermining rival traditions. The import of a new model inevitably disturbs the existing science system, bringing new actors to the front and displacing others from their positions. The introduction of the German model, with its emphasis on the building of large laboratory facilities, caused increased tension with traditional forms of knowledge such as that embodied in scientific societies or non-laboratory-based disciplines. When in Belgium the large laboratories were built in the final decades of the nineteenth century, it put the power of scientific research in the universities, while the Royal Academy of Science lost much of its influence in Belgian scientific life. The introduction of agricultural stations replaced traditional agricultural practices and may even have been detrimental to local scientific research. Louis Ferleger has argued that the success of the German agricultural stations actually caused a setback of agricultural efficiency in most North Sea countries where the German stations were admired and copied. Those countries neglected to provide enough funding for sustained agricultural research and relied too much on German knowledge, which was not adapted to their local needs (Ferleger 2005). Similar evolutions can be seen in the introduction of bacteriological laboratories, replacing the expertise of hygienists.

The German model also interfered with the balance between pure and applied research. Introducing laboratories in engineering education sometimes served to make the engineer appear more scientific, thus increasing the social distance with lower technical personnel. Similarly, the large laboratories available to university researchers emphasized the difference between professional researchers and amateurs. Last but not least, the German model also identified local scientists as knowledgeable experts on the basis of their acquaintance with and advocacy for German science.

Conclusion

The widespread emergence of the German model in the nineteenth century can be interpreted as a unifying European phenomenon, in the sense that it united widely differing national scientific cultures in the recognition that the German science system was the very epitome of modern science. However, as we have demonstrated with the few examples in this paper, the German model was not a static, well-defined system that other countries envied and were ready to copy.[5] Rather, the very definition of the German model, the values associated with it and the actual consequences of the adoption of the model varied largely among European countries.

A better way to understand the international appeal of the German model may be to look at it from the complementarity model of centre and periphery. The German science system, as conceptualized by numerous authors throughout Europe, embodied the central values of modern science and was thus a crucial binding element to bring different scientific traditions together within one community. Importantly, the label 'periphery', which suggests itself in studying the spread of the German model, should to be seen as an intentional localization of European countries around the centre. The 'adoption' of the German model, instead of being a mark of emulation of the centre by the periphery, can be understood to emphasize the modernity of the adopting country, its very nearness to the centre, and its acceptance of the central values of modern science.

[5] This can also be said for German institutions, which were actually in a constant state of transformation. See e.g., Cahan (1985).

References

Amaral, Isabel. 2006. The emergence of new scientific disciplines in Portuguese medicine: Marck Athias's histophysiology research school, Lisbon (1897–1946). *Annals of Science* 63:85–110.

Basalla, George. 1967. The spread of Western science. *Science* 156: 611–622.

Ben-David, Joseph. 1969. The rise and decline of France as a scientific centre. *Minerva* 6:160–179.

Bertrams, Kenneth. 2006. *Universités et entreprises. Milieux académiques et industriels en Belgique 1880–1970*. Brussels: Le Cri.

Blay, Michel, and Efthymios Nicolaïdis, eds. 2001. *L'Europe des sciences. Constitution d'un espace scientifique*. Paris: Editions du Seuil.

Burguete, Maria. 2010. Laboratories at the faculty of medicine of the University of Coimbra in the XIX century. *Scientific Research and Essays* 5:1402–1417.

Cahan, David. 1985. The institutional revolution in German physics, 1865–1914. *Historical Studies in the Physical Sciences* 15 (2): 1–65.

Casalena, Maria Pia. 2007. The congresses of Italian scientists between Europe and the Risorgimento (1839–75). *Journal of Modern Italian Studies* 12:153–188.

Crosland, Maurice. 2005. Early laboratories c.1600-c.1800 and the location of experimental science. *Annals of Science* 62 (2): 233–253.

Cueto, Marcos. 2006. Excellence in twentieth-century biomedical science. In *Science in Latin America. A history,* ed. J. J. Saldaña, 231–239. Austin: University of Texas Press.

Despy-Meyer, Andrée, and Didier Devriese. 1993. Paul Heger, maître d'oeuvre des instituts d'enseignement et de recherche en sciences médicales voulus par Ernest Solvay à Bruxelles (1891–1895). In *De toga om de wetenschap. Ontwikkelingen in het hoger onderwijs in de Geneeskunde, Natuurwetenschappen en Techniek in België en Nederland (1850–1940),* eds. L. C. Palm, G. Vanpaemel, and F. H. van Lunteren, 90–103. Rotterdam: Erasmus Publishing.

Diser, Lyvia. 2012. Laboratory versus farm: The conquest of laboratory science over tradition in Belgian agriculture at the end of the nineteenth century. *Agricultural History* 86:31–54.

Elina, Olga. 2002. Planting seeds for the revolution: The rise of Russian agricultural science, 1860–1920. *Science in Context* 15:209–237.

Fauque, Danielle. 2005. Organisation des laboratoires de chimie à Paris sous le ministère Duruy (1863/1869): Cas des laboratoires de Fremy et de Wurtz. *Annals of Science* 62:501–531.

Ferleger, Louis A. 2005. European agricultural development and institutional change: German experiment stations, 1870–1920. *The Journal of The Historical Society* 5:417–428.

Finlay, Mark. 1988. The German agricultural experiment stations and the beginnings of American agricultural research. *Agricultural History* 62:41–50.

Fox, Robert. 1973. Scientific enterprise and the patronage of research in France 1800–70. *Minerva* 11:442–473.

Fox, Robert. 1990. The view over the Rhine: Perceptions of German science and technology in France, 1860–1914. In *Frankreich und Deutschland. Forschung, Technologie und industrielle Entwicklung im 19. Und 20. Jahrhundert,* eds. Y. Cohen and K. Manfrass, 14–24. Munich: C.H. Beck Verlag.

Fox, Robert, and Anna Guagnini. 1999. *Laboratories, workshops, and sites. Concepts and practices of research in industrial Europe, 1800–1914*. Berkeley: University of California.

Gavroglu, Kostas, Faidra Papanelopoulou, Ana Simões, Ana Carneiro, Maria Paula Diogo, José Ramón Bertomeu Sánchez, Antonio García Belmar, and Agustí Nieto-Galan. 2008. Science and technology in the European periphery: Some historiographical reflections. *History of Science* 46:153–175.

Gillis, Jan. 1959. *Kekulé te Gent (1858–1867). De geschiedenis van de benoeming van August Kekulé te Gent en de oprichting van het eerste onderrichtslaboratorium voor scheikunde in België*. Brussels: Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België. Klasse der Wetenschappen.

Gizycki, Rainald von. 1973. Centre and periphery in the international scientific community: Germany, France and Great Britain in the 19th Century. *Minerva* 11 (4): 474–494.
Gizycki, Rainald von. 1979. The associations for the advancement of science. An international comparative study. *Zeitschrift für Soziologie* 8:28–49.
Haines, George. 1958. German influence upon scientific instruction in England 1867–1887. *Victorian Studies* 1:215–244.
Hannaway, Owen. 1976. The German model of chemical education in America: Ira Remsen at Johns Hopkins (1876–1813). *Ambix* 23:145–164.
Hennock, E. P. 1990. Technological education in England, 1850–1926: The uses of the German model. *History of Education* 19:299–331.
Hofmann, A. W. 1866. *The chemical laboratories in course of erection in the universities of Bonn and Berlin. Report*. London: W. Clowers and Sons.
Homburg, Ernst. 1992. The emergence of research laboratories in the dyestuffs industry, 1870–1900. *The British Journal for the History of Science* 25:91–111.
Hutchinson, John F. 1985. Tsarist Russia and the bacteriological revolution. *Journal of the History of Medicine and Allied Sciences* 40:420–439.
Huxley, Thomas H. 1896. *Science and Education. Essays*. New York: D. Appleton and Company.
Jas, Nathalie. 2000. *Au carrefour de la chimie et de l'agriculture. Les sciences agronomiques en France et en Allemagne 1840–1914*. Paris: Éditions des archives contemporaines.
Kernbauer, Alois. 1997. The scientific community of chemists and physics in the nineteenth-century Habsburg Monarchy. *Centre for Austrian Studies*: Working Paper 95–4.
Kichigina, Galina. 2009. *The imperial laboratory: Experimental physiology and clinical medicine in post-Crimean Russia*. Amsterdam: Rodopi.
Kubbinga, Henk. 2010. A tribute to Wróblewski and Olszewski. *Europhysics News* 41:21–24.
Nye, Mary Jo. 1984. Scientific decline: Is quantitative evaluation enough? *Isis* 75:697–708.
Pancaldi, Giuliano. 1998. The German model and the origins of the Italian Riunioni degli scienziati. In *Zwei Jahrhunderte Wissenschaft und Forschung in Deutschland. Entwicklungen – Perspektiven,* ed. Dietrich von Engelhardt, 171–178. Stuttgart: Wissenschaftliche Verlagsgesellschaft mbH.
Pasteur, Louis. 1868. Le budget de la science. *Revue des cours scientifiques* 5:137–139.
Paul, Harry. 1972. The issue of decline in 19th century French science. *French Historical Studies* 8:416–450.
Polanco, Xavier, ed. 1989. *Naissance et développement de la science-monde. Production et reproduction des communautés scientifiques en Europe et en Amérique Latine*. Paris: Éditions La Découverte.
Raj, Kapil. 2006. *Relocating modern science. Circulation and the construction of scientific knowledge in South Asia and Europe. Seventeenth to nineteenth centuries*. Delhi: Permanent Black.
Roderick, G. W., and M. D. Stephens. 1982. Scientific education in England and Germany in the second half of the nineteenth century. *Irish Journal of Education* 16:62–83.
Schott, Thomas. 1993. World science: Globalization of institutions and participation. *Science Technology Human Values* 18:196–208.
Schwinges, Rainer Christoph, ed. 2001. *Humboldt International. Der Export des deutschen Universitätsmodells im 19. und 20. Jahrhundert*. Basel: Schwabe & Co. AG Verlag.
Shils, Edward. 1961. Centre and periphery. In *The logic of personal knowledge: Essays presented to Michael Polanyi*, ed. Marjorie Grene, 117–130. London: Routledge & Kegan Paul.
Van Tiggelen, Brigitte. 1993. De la chaire aux laboratoires: Louis Henry et la professionalisation de la recherche en sciences naturelles en Belgique. In *De toga om de wetenschap. Ontwikkelingen in het hoger onderwijs in de Geneeskunde, Natuurwetenschappen en Techniek in België en Nederland (1850–1940),* eds. L. C. Palm, G. Vanpaemel, and F. H. van Lunteren, 78–89. Rotterdam: Erasmus Publishing.
Weisz, George. 1983. *The emergence of modern universities in France, 1863–1914*. Princeton: Princeton University Press.
Wurtz, Adophe. 1870. *Les hautes études pratiques dans les universités allemandes*. Paris: Imprimerie Impériale.

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Chapter 14
Foundation of the Lisbon Polytechnic School Astronomical Observatory in the Late Nineteenth Century: A Step Towards Establishing a University

Luís Miguel Carolino

This paper focuses on the establishment of an Astronomical Observatory at the Lisbon Polytechnic School (hereafter AOLPS) in the 1870s and explores its interplay with the launching of an astrophysics research programme at this technoscientific school. With the aim of making this observatory a reference institution in astrophysics and astronomical photography in Portugal, the board of directors of the Lisbon Polytechnic School (hereafter LPS)—some of them influential figures in Portuguese political scenario—strove to staff and equip the observatory appropriately. Instruments were ordered from chief European and American instrument-makers and an AOLPS astronomer was enrolled for a European tour to study research programmes, methodologies and instruments in use in some of the leading astrophysical observatories. While approaching the British case, Roger Hutchins has stressed the challenging character that the establishment of an astrophysics research programme represented to university observatories in the late nineteenth century. In the context of international competition, the long-term vulnerable university observatories "had to change or succumb" (Hutchins 2008, p. 167). While focusing on the way AOLPS dealt with this challenge, Portuguese authors have unanimously agreed that AOLPS succumbed. Three sorts of reasons have been invoked in order to explain such a "failure": wrong decisions taken by university administrators, lack of first-rate instruments, and observatory architectural oddities (Andreia 1937, p. 23; Bonifácio 2009, pp. 260–261, 342–346; Silva 1996, v. I, Silva 1998, pp. 127–128; Rivotti and Sepúlveda 1987, p. 181).

In this paper, I shall argue that the option taken at LPS for an astrophysics research programme, far from being motivated by a purely 'scientific' reason, can be related to issues of academic prestige and capacity to influence scientific and educational policies at a national scale. More particularly, the establishment of AOLPS took place at a time when LPS academic staff increasingly vindicated the university status for its institution. At that time, the University of Coimbra (UC) had the

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monopoly of university education in Portugal.[1] Of course, the wish to put LPS in balance with the more recent developments in astronomy was not absent. Yet, the option for astrophysics was not a self-evident one, as some historians of astronomy anachronistically seem to think. I shall demonstrate that LPS's option for an astrophysics research programme and its decision to implement a certain model of observatory depended largely upon LSP institutional policy as well upon the personal agendas of its professors. The 'astrophysics event' associated with the building of AOLPS was thus part of a broader and more complex story.

A comprehensive approach to this story will provide historians with an insight into the role played by universities[2] in countries of the European periphery and, particularly, into the difficulties of launching scientific research in peripheral contexts. The support for an astrophysics research programme within a university astronomy observatory is a telling case. At the end of nineteenth century, astrophysics provided university observatories with the chance to assume the leadership in astronomy. National observatories were mostly concerned with meridian astronomy, having established their reputation within this prestigious branch of astronomical science. Furthermore, practical usefulness of astrophysics was not discernible. Therefore, there were no pressing reasons to adopt a newly arising research programme. With university observatories, the situation was entirely different. Traditionally underbudgeted and provided with a staff responsible not only for research but also for teaching, university observatories were hardly in a position to compete with national observatories in meridian work. The option for astrophysics at this initial stage would thus benefit university observatories. Furthermore, universities were better prepared to meet the multi-disciplinary expertise imposed by astrophysics research, as they could easily recruit chemists and physicists to work alongside mathematicians, who traditionally assumed the research positions in astronomical observatories. Accordingly, in the first decades of the twentieth century, universities increasingly adopted astrophysics. This is particularly true for universities organized according to the Humboldtian model of university, where research and teaching were closely connected, such as those in North America and some in Britain (Hutchins 2008; Lamy and Gingras 2008; Lankford 1997).

In a peripheral country such as nineteenth-century Portugal, astrophysics was also perceived to be a suitable opportunity to attain some distinction in the scientific scenario. Professors of LPS, for example, stated, in the 1870s that "the highest scientific importance of this sort of works is undeniable."[3] Nevertheless, despite the construction of AOLPS and the efforts to acquire instruments and train scientific personnel, the adoption of astrophysics was not as promising as the LPS professors had expected. Very little work was ultimately accomplished in this scientific area. I shall argue that this was the result neither of wrong decisions nor of instrumental constraints. The incapacity of AOLPS to distinguish itself as a research

[1] An overview of university teaching in Portugal at the turn of nineteenth century can be found in Carvalho(1986) and Brandão and Almeida (1937). See also *Universidades(s)* (1991).

[2] LPS was soon upgraded to Faculty of Sciences of the University of Lisbon.

[3] Arquivo Nacional da Torre do Tombo (ANTT), Ministério do Reino, mç. 3668, fl. n.n.

institution basically resulted from the higher education institutional context in which it emerged. In a peripheral country, where scientific professions scarcely existed, the main educational motivation of faculties of science was to provide applied education to students and prospective civil servants. In this context, there was little room to implement an educational policy based upon research. This seems to be particularly effective in the case of university astronomy observatories of the European periphery. Pedro Ruiz-Castell has already demonstrated the same tendency with regard to Spanish university observatories (Ruiz-Castell 2008, pp. 89–108). In the end, one might claim, there was no need for astrophysics.

Nevertheless, the building of AOLPS and the initial choice of astrophysics and astronomical photography as the main topic of research can hardly be characterized as a failure. Providing the School with such research facilities arguably played an important part in the institutional policy of LPS. Indeed, the LPS academy staff eventually succeeded in having their institution recognized as a faculty of science. In 1911, in the aftermath of the Republican revolution (5 October 1910), the LPS was transformed into the Faculty of Sciences of the University of Lisbon. Historians have recognized that symbolic factors played a key role in the founding of nineteenth- and twentieth-century observatories (Bennett 1987; Hutchins 2008; Aubin et al. 2010a, b; Werrett 2010). I shall argue along these lines. An analysis of the architectural morphology of AOLPS buildings suggests that this observatory was built not only for the educational services it could render, but also for political/ideological purposes. The academic staff of LPS aimed for their institution to be promoted to university status, and the construction of an observatory was key to such aim.

14.1 The Foundation of AOLPS

The few historians who focused on the foundation of AOLPS, relating it to the attempt of launching a research programme on astrophysics, tended to undervalue the institutional context in which that foundation took place.[4] AOLPS was originally planned in order to support the teaching of astronomy at a polytechnic school (LPS). It belonged to a group of scientific-pedagogical institutes created when LPS was founded in 1837, in the aftermath of a long civil war, which opposed 'Liberals' to 'Absolutists'. Those institutes (*estabelecimentos*) comprised one library, one cabinet of physics, one chemical laboratory, one cabinet of natural history, one botanical garden and one astronomical observatory.[5] The first historians of AOLPS did not ignore this very fact. Nevertheless, their historiographical conception of the history of nineteenth- and twentieth-century astronomy as a progressive shift

[4] A very preliminary history of AOLPS can be found in Andreia (1937, p. 23–24), Silva (1996, vol. I), Silva (1998), Rivotti and Sepulveda (1987), Bonifácio (2009, pp. 245–261), and Carolino (2011).

[5] *Collecção de Leis e Outros Documentos Officiaes publicados no 1º semestre de 1837: art. 4.*

from positional astronomy to astrophysics led them to take it as an incidental event. Although AOLPS came out as teaching observatory, according to those historians, its place in the history of astronomy was to be judged by its discoveries, technical improvements and by the ground-breaking theories that its professors and researchers were (un)able to put forward.

Nevertheless, the institutional context in which the Observatory emerged proved to be decisive in its development. When LPS was created, it was originally intended to train the State technical personnel, which meant by-and-large officers, military, navy and civil engineers, as well as to provide the prospective students of medical and chirurgical schools with propedeutical scientific training.[6] This being the case, the astronomical course of LPS focused especially on the practical applications of astronomy. Accordingly, the first professor of astronomy at the LPS, Filipe Folque, who taught from 1837 to 1856 and played a pivotal role in the geodetic survey carried out in the second half of the nineteenth century, a process which culminated with the publication of the geographic map of Portugal (1865), elected spherical astronomy as the content of his course. Nineteenth-century astronomers divided astronomy into two main branches, theoretical (also called celestial mechanics after Laplace's *Mécanique Céleste*) and spherical (Main 1863, p. 1; Brünnow 1865, p. 70; Carvalho n.d. 1890s, pp. 3–4; Chauvenet 1863, I:17–18; Newcomb and Holden 1889, pp. 2–3).[7] Theoretical astronomy, also identified at the time as "physical astronomy", consisted of the study of the laws of motion of the celestial bodies as they were deduced from the application of Newton's theory of gravitation. Spherical astronomy dealt with the location and *directions* of celestial bodies as determined from the observation at a particular time and position on Earth. This applied branch was particularly useful for cartography, nautical science and surveying. It was thus indispensable in the training of officers, military, navy and civil engineers. Folque played a key role in the shaping of astronomy teaching at LPS (Carolino 2012); for decades, professors of LPS taught basically spherical astronomy (see, for example, Carvalho n.d. 1890s; Andreia 1937).

Although no reports of practical lessons of astronomy at LPS seem to have survived, an analysis of the astronomy syllabus and exam programmes suggests that students were basically asked to describe, calibrate and use instruments such as the transit instrument, circumferentor, quadrant and pendulum clock in order to find

[6] Four courses addressed respectively to military officers and to military and civil engineers (1st course), to artillery officers (2nd course), to navy officers (3rd course) and to navy engineers (4th course) were given at this institution. A fifth and general course including whole disciplines taught at the School was also planned. Apart from these courses, students of medicine and pharmacy also made their scientific preliminary studies at the Lisbon Polytechnic School. *Collecção de Leis* (1837, pp. 53–54).

[7] As the nineteenth century progressed, astronomers tended to distinguish a third branch of astronomy, called occasionally "cosmic physics" or "physical astronomy", which focused on the physical constitution of the celestial bodies and on the structure of heavens (for example, Newcomb and Holden 1889, p. 3). With the development of spectroscopy, this branch paved the way for astrophysics.

time, latitude and longitude by astronomical observations.[8] Initially, the AOLPS served thus a strong practical purpose.

Despite the fact that an astronomical observatory was already foreseen in the founding decree of LPS, the AOLPS was not built until the 1870s. Despite the fact that the academic staff of LPS, from time to time, claimed that an astronomical observatory ought to be built,[9] in the first decades, students of astronomy received practical training at the Navy Royal Observatory (NRO), an observatory temporarily established in the campus of LPS (Reis 2009, pp. 74–75). In the 1840s, the astronomical observatory was moved to the Navy arsenal, near Tejo River, as a result of a fire that consumed part of LPS building, in 1843. This observatory decayed during the next decades, being in a very poor condition in the 1850s and 1860s, according to Folque (1866). In the early 1870s, it became clear that the NRO could no longer be used appropriately for the teaching of astronomy and that a new astronomical observatory should be erected. By then, a major astronomical observatory dedicated to research on astrometry was already built in Portugal, the Astronomical Observatory of Lisbon (hereafter AOL) (see Raposo 2009, 2010, 2011). Yet, not only the astronomers of AOL considered inappropriate the use of OAL and its instruments for teaching purposes (Oom 1875). Professors of LPS, Navy School and Military School also took the high quality of OAL's instruments and its distance from the center of Lisbon to be strong disadvantages. When asked by a commission of the Elected Chamber of the Parliament: (1) whether it was necessary an astronomical observatory to support the teaching of astronomy, geodesy and hydrography; (2) whether the NRO could perform such role; and (3) in case the NRO was demolished, whether the students could make use of AOL, the committees representing those three schools unanimously considered that a new astronomical observatory had to be constructed.[10] The NRO was extinguished in 1874.

14.2 The Origin of a Research Programme

On the 28th April 1871, after receiving the questionnaire from the Elected Chamber of the Parliament with the three questions above mentioned, the board of professors of LPS designated a committee to analyse this issue.[11] The committee comprised all of the professors of mathematics of LPS (as astronomy was considered a 'mathematical chair'). On that occasion, all the professors agreed that each

[8] Arquivo Histórico do Museu Nacional de História Natural e da Ciência (hereafter AH-MNHNC), *Programma d'Astronomia que foi objecto da 4ª Cadeira na Escola Polytechnica no anno lectivo de 1836 a 1837*, Cxa. 1606, f.n.n. [Programma dos exames] 4ª cadeira, Cxa. 1606, fl.n.n. See also Folque (1840, pp. 36–50).

[9] See *Actas do Conselho* [Minutes of the Board of LPS], liv. 1, 27 October 1838, liv. 2, 24 March 1842.

[10] *Diário do Governo*, 14 September 1871.

[11] *Actas do Conselho*, 28 April 1871, liv. 6, pp. 116–117.

school, Polytechnic included, should have a small observatory for practical teaching ("*pequenos observatórios de estudo*"). From their point of view, those observatories were supposed to be anything but "one house provided with one transit instrument, one theodolite, one Repsold universal instrument, one pendulum clock and some telescopes".[12] The instruments that existed in the NRO were sufficient to equip two or three of these small observatories, mathematical professors of LPS considered.[13]

The first idea for an astronomical observatory at the LPS was, thus, to build a small observatory for teaching purposes. Yet, the decision changed when, on the 30th October 1872, Mariano Cirilo de Carvalho was entrusted with writing a statement on the construction of AOLPS.[14] From then on, Carvalho kept the building of AOLPS under his close surveillance. AOLPS was to a certain extent *his* observatory, being appointed its first director.[15] Apart from being professor of astronomy at LPS (between 1867 and 1870, as a substitute professor, then 1892–1897, as chair), Cirilo de Carvalho was a flamboyant and highly influential politician. Successively elected to Parliament from 1870 to 1905, Chancellor of the Exchequer (1886–1888, 1891–1892) and *Ministro do Reino* (Home secretary: 1891), de Carvalho was an ambitious politician. He founded the *Partido Progressista* (Progressive Party) in 1876, and for years aspired in vain to preside over it.[16] Partido Progressista was a key party in Portuguese politics in the late nineteenth century; presiding over this party meant, sooner or later, becoming the ruler of the Portuguese government.

Cirilo de Carvalho turned the idea of building a "small teaching observatory" into an observatory devoted to research.[17] Yet, it is unlikely that the option for an astrophysical research programme was his own. He did not publish original papers neither in astronomy nor in astrophysics. When teaching astronomy, his course focused on spherical astronomy (Carvalho n.d. 1890s). In what concerns science, de Carvalho was to distinguish himself especially in science politics. In addition to playing the key role in the foundation of AOLPS, he would preside over the committee that the Portuguese government established in order to facilitate the expedition and observations carried out by foreign astronomers who came to Portugal to observe the total solar eclipse of 30 May 1900. Those astronomers included, for example, the British Royal Astronomer William Christie, and his assistants C. Davidson and F. Dyson (see Carolino and Simões 2012).

It is most likely that the plan to turn AOLPS to astrophysical research arose in the context of a commission established by LPS academic staff, on the 24th

12 *Diário do Governo*, 14 September 1871.

13 *Diário do Governo*, 14 September 1871.

14 *Actas do Conselho*, 30 October 1872, liv. 6, 140.

15 Evidence points to the fact that Carvalho considered the AOLPS as 'his own observatory'. For example, he used some AOLPS instruments at his discretion, not hesitating in taking them with him. *Actas do conselho,* 1 October 1891, liv. 7, 103.

16 A political biography of Carvalho (though completely ignoring his 'scientific' career) can be found in Fernandes (2010).

17 Mariano Cirilo de Carvalho's engagement in the establishment of AOLPS was later recognized by the director of LPS—see Escola Politécnica (1878, p. 10 (see also p. 41).

March 1873, with the aim of studying the project of the Polytechnic observatory.[18] The commission comprised de Carvalho and other LPS professors Francisco Horta, Henrique de Macedo Pereira Coutinho, by the civil engineer Luís Victor Le Cocq[19], and by the prominent astronomer Frederico Oom, director of AOL, who had received astronomical training at the Observatory of Pulkovo (Russia). It has not been possible so far to locate any report elaborated by this commission. Yet this commission most likely worked out the notion of institutional cooperation between the Lisbon astronomical observatories. According to this notion, AOL and AOLPS should not compete in scientific terms but complement one-another, which meant that each observatory should be concerned with its own subject of research. This understanding resulted in all probability from the interaction with Frederico Oom. Pedro Raposo has demonstrated that, as director of OAL, Oom (and after him, Campos Rodrigues) was engaged, on the one hand, in securing the position to OAL in international astronomy and, on the other hand, in distinguishing it as the national observatory, by carrying out traditional meridian work (Raposo 2010). Accordingly, there was no room for another first-class meridian observatory in Lisbon, nor presumably in Portugal. Constraints affecting university observatories, already mentioned, also prevented the adoption of a research programme based upon meridian astronomy. The newly established studies in spectroscopy and astronomical photography emerged as an optimal solution to AOLPS.

The notion of institutional cooperation between Lisbon astronomical observatories and, therefore, the assumption that AOLPS was to distinguished itself by its committed research in astrophysics and astronomical photography was fully incorporated in the institutional discourse of LPS by the mid-1870s. The LPS's academic staff invoked this argument in order to recommend the sending of an astronomer of AOLPS to study aboard.[20] The very same reasoning was expressed by the director of the Polytechnic School, João de Andrade Corvo, when King Luís paid a visit to LPS, on the 21st December 1877. While delivering his address in the king's presence, Andrade Corvo claimed that "it is easy to acknowledge that the two observatories, recently built in Lisbon, coexisting and pledging thorough their unceasing work to achieve an eminent position in science, cannot but cooperate, complement each other, and increase scientifically, not by sterile rivalry, but through solid competence" (Escola Politécnica 1878, pp. 9–10). As far as the research programme of AOLPS was concerned, the director pointed out that this institution was committed to carrying out spectroscopic study of celestial bodies, astronomical photography and the regular study of the bodies of the solar system (Escola Politécnica 1878, p. 9).

The conception of an observatory initially planned to provide practical training to students ended up thus converted into a research institution devoted to spectroscopic studies and astronomical photography. This upgrade required further training

[18] *Actas do Conselho*, 24 March 1873, liv. 6, pp. 145–146.

[19] I thank Pedro Raposo for helping me to identify engineer Le Cocq.

[20] *Parecer do Conselho da Escola Politecnica de Lisboa sobre a ida do astrónomo…*, 21 May 1877, ANTT, Ministério do Reino, mç. 3668, fl. n.n.

of the academic staff and, needless to say, the acquisition of specific instruments. As often happened when an astronomical observatory was built in the nineteenth century, the Polytechnic professors felt it necessary to send an astronomer/professor of mathematics to study and became acquainted with the more recent methods, procedures and instruments used in astrophysical studies elsewhere. At suggestion of Cirilo de Carvalho, LPS academic staff decided to address a requirement to the Portuguese government to that purpose.[21] After previous consultation, only the substitute professor of astronomy Henrique de Macedo Pereira Coutinho did offer to take such tour.[22]

Pereira Coutinho's tour was supposed to take 8 months, the first four being dedicated to the astronomical observatories of Rome and Florence and the remainder to the observatories of Paris and Greenwich. In the first travel, initiated in July 1877, Coutinho took advantage of traveling through Paris to pay a visit to the astronomical observatory of Paris and Meudon, where he met Pierre Jules Jassen (1824–1907), a French solar physicist and founding director of the national astrophysical observatory at Meudon. In Italy, he visited the Brera Observatory in Milan, being introduced to its director Giovanni Schiaparelli (1835–1910), a celebrated astronomer and author of some classical treatises on the history of astronomy, made some spectroscopic observation at the Observatory of Florence, and worked for 3 months with Lorenzo Respighi, director of the Observatory of the Capitol, on spectroscopic observations of the sun.[23] In November, he returned to Lisbon, departing again in May 1878 for the second part of his tour.[24] After returning to Portugal, Coutinho resumed his position of professor of astronomy in the 1881/1882 academic year.[25] Notwithstanding this professional development opportunity, he abandoned scientific research in favour of a career in politics. In February 1886, he was appointed Ministry of Navy in the same government of Cirilo de Carvalho (when Chancellor of the Exchequer) (Fernandes 2010, p. 226).

As far as the instruments are concerned, AOLPS basically received instruments from the extinct NRO. Yet, the option to embark on astrophysics research led to the need of acquiring new instruments. In 1878, AOLPS was already provided with one solar spectroscope made by Browning, one stellar spectroscope also by Browning, and a direct vision spectroscope produced by Merz.[26] An 11" photographical equatorial ordered from Alvan Clark was also expected to enrich AOLPS, but, in the end, this instrument did not make its way to Lisbon.[27] By the late 1870s, AOLPS was almost prepared to launch into its spectroscopic research programme and astronomical photography work.

[21] Office letter 29 May 1877, ANTT, Ministério do Reino, mç. 3668, fl. n.n.

[22] Office letter 1 June 1877, ANTT, Ministério do Reino, mç. 3668, fl. n.n.

[23] *Relatório apresentado pelo lente da Escola Polytechnica… 1ª parte da comissão…*, ANTT, Ministério do Reino, mç. 3668, fl. n.n.

[24] I am not aware of the existence of any reports concerning this second tour.

[25] Previously, Pereira Coutinho taught astronomy in 1866–1867, 1871–1873 and 1875–1876.

[26] Escola Politécnica (1878, pp. 43–44).

[27] Escola Politécnica (1878, pp. 43–44). See Bonifácio (2009, pp. 288–289).

14.3 The Wish to Become a University

Mariano Cirilo de Carvalho's involvement in making AOLPS a research institute served his political agenda. Nevertheless, it also suited very well for a more institutional purpose. It matched the increasingly dominant ambition among professors of Lisbon Polytechnic for their institution to be recognized as a university. An analysis of the relationship between the UC and the LPS is beyond the scope of this study. However, an overview of the minutes of the board of LPS professors shows that there was an increasing tension between the two educational institutions, which arose especially in issues such as correspondence of degrees and curricula.[28] As the nineteenth century progressed, professors of LPS push for the establishment of curricula similar to those found in the UC. In June 1867, for example, LPS professors were deeply involved in discussing the establishment of university disciplines such as celestial mechanics.[29]

The aim to have LPS recognized as a university was clearly expressed by Andrade Corvo at the national Parliament House. While making his speech to the Parliament's commission in charge of analysing public education in Portugal, in early April 1866, Andrade Corvo uncovered the LPS's wish of becoming a university. According to him, that aim was part of a broader problem regarding Portuguese higher education. In his words, "if institutions of public higher education in Portugal focused deeply in its role, *if Lisbon Polytechnic School and the Polytechnic Academy of Porto did not want to become a university faculty*, and if the university did not wish to become the polytechnic school or academy (…), it would be better for the higher education and for the importance of institutions of higher education as well" (Corvo 1866, p. 77).

Andrade Corvo disagreed with the pretension exhibited by the professors of LPS. Nevertheless, and despite being a very influential figure in the school as well as in Portuguese politics, he belonged to a minority group. In fact, generations of professors at LPS cleared the way for the transformation of the Polytechnic into a university faculty. In early 1911, LPS professors elaborated a draft regarding the transformation of this school into two faculties, a faculty of science and a technical university.[30] However, this plan was not put into practice. In May 1911, in the aftermath of the Republican revolution, the LPS school was extinguished, giving origin to the Faculty of Sciences of the University of Lisbon. In the first decades, professors of the Faculty of Sciences perceived themselves to be the heirs of LPS.[31]

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[28] See, for example, *Actas do Conselho*, 4 February 1843, liv. 2; 8 October 1859, liv. 5; 11 January 1911, liv. 8; 26 June 1902, liv. 8; 21 June 1904.

[29] *Actas do Conselho*, 1 June 1867, liv. 6, pp. 51–54.

[30] *Ante-Projecto de Organização dos Cursos da Escola Polytechnica de Lisboa*, 1911, AH-MNHNC. I would like to thank Teresa Salomé Mota for drawing my attention to this document, which she has located.

[31] For example, Cunha (1937).

14.4 Symbolic Architecture

Scientific and teaching facilities are used not only to develop scientific research and teaching science, they are also endowed with symbolism. Facilities such as a magnificent chemical laboratory or an impressive astronomical observatory were central for expressing institutional importance and social utility of institutions. In the nineteenth century, they served to perpetuate the portrait of these institutions as nuclear centres for the progress of society. This symbolic meaning explains why such scientific and teaching facilities were used as the stage on which ceremonial and highly symbolic events took place.

For example, as already mentioned, in December 1877, King Luís paid a visit to LPS. The official purpose was to deliver prizes to the winning students of the academic year 1876/1877. Yet, the political and social involvement made the event quite remarkable. On this occasion, the king was received with great magnificence at the chemical laboratory, and not at the school's political centre, the professorial assembly room, as might have been expected.[32] After the reception at the school's entrance by the director and the academic staff of the School and by the prime minister and the minister of war, the king went on to the laboratory, crossing its room, where he was welcomed by the ambassadors of England, Italy, Germany, Austria, Russia and Brazil and a delegate representing France, by members of State council, members of the Royal Academy of Sciences of Lisbon, professors of other Lisbon scientific teaching institutions, the director of Portuguese central bank, as well as by a few journalists and "several other people of distinction who had been invited to this ceremony" (Escola Politécnica 1878, p. 2). Finally, King Luís entered the impressive amphitheatre of the laboratory. There he witnessed, as his brother King Pedro V had in 1857, that the chemical laboratory was a luxury facility, well provided in order to support the teaching of chemistry at LPS, an institution that could very well strive to be recognized as a university faculty. In the late 1870s, Agostinho Vicente Lourenço, professor of organic chemistry and chemical analysis at LPS, described the chemical laboratory as "vaster and, at the same time, more spectacular than all the other laboratories of Europe" (Escola Politécnica 1878, p. 53).[33]

The same facility was used in other highly symbolic events, such as the public academic examinations that took place during the application for a professorial post. A case in point is the application for the position of professor of political economy, which happened in March 1911. One of the candidates was the Minister of Justice Afonso Costa, who would become a key figure in Portuguese politics during the First Republic (1910–1926). The examination process took place in the chemical laboratory. The newspaper *Ilustração Portuguesa* covered the event, showing that there was high participation.[34] The amphitheatre was crowded (Fig. 14.1).

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[32] The visit was described at Escola Politécnica (1937), pp. 1–2).

[33] On the chemical observatory of LPS, see especially Leitão and Carneiro (2011) and Carneiro (2011).

[34] *Ilustração* Portuguesa, 266, 27 March 1911, pp. 10–11.

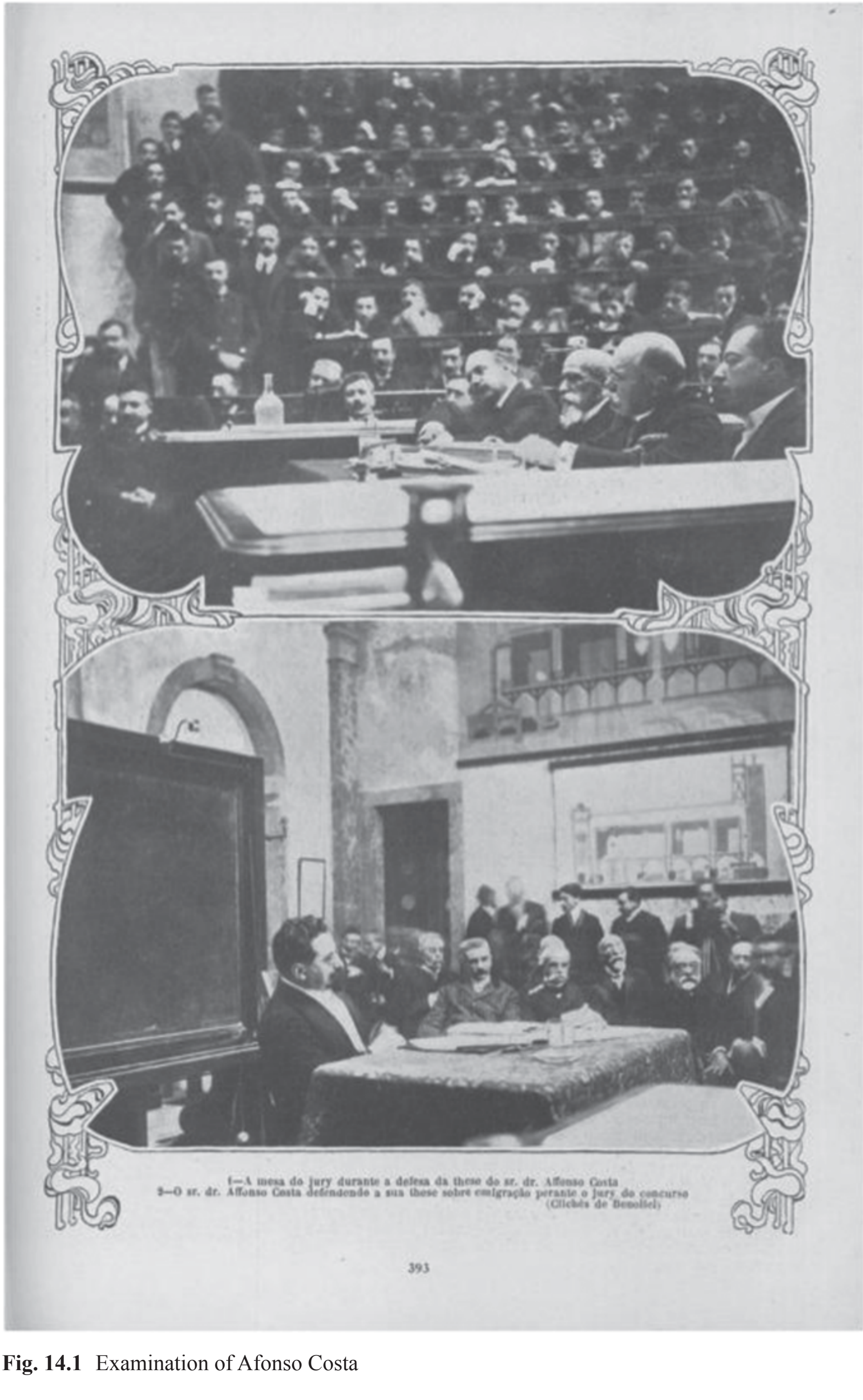

Fig. 14.1 Examination of Afonso Costa

The symbolic meaning of scientific institutions is also decisive in order to understand the building of AOLPS, and particularly its location and the architectural morphology of its buildings. AOLPS was built in the campus of the LPS in 1875. Nevertheless, the decision regarding the place where it should be erected was already taken several years before. In fact, on the 23rd February 1863, professors decided that the astronomical observatory was to be constructed in the northern part of LPS's campus,[35] which means in the botanical garden. The decision proved to be highly problematic. The botanical garden was (is) divided into two different floors, a superior and an inferior and sloping ground in between. The Observatory ought to have been constructed on the superior floor. Yet, a technical problem existed: the superior floor was made up of compacted materials, which means that it was not provided with the correct strength and conditions of stability required for this sort of building. Professors were certainly aware of that fact because it had been a topic of intensive analysis when the AOL was built, roughly in the 1860s (Raposo 2010, Chap. 4). Building an astronomical observatory in the botanical garden had another technical inconvenience: soon there would be no free horizons. This inconvenience could only be overcome by installing the main instruments on the observatory's upper floor (which ended up being the case). Nevertheless, this solution made the problem of stability even worse, putting into serious risk the quality and exactness of the observations to be carried out there. To these two main technical problems, one could add a third inconvenience: being placed not far away from the centre of the city, astronomical observations were prejudiced by excessive luminosity.[36]

Why, then, did professors of LPS decide to erect AOLPS in the botanical garden? Practical reasons can be invoked: it was easier for students to attend practical lessons of astronomy at the School. Nevertheless, a stronger reason likely played a key role in that decision. The building of an astronomical observatory with research pretensions was decisive to prove to the educational authorities of the country that LPS was provided with adequate conditions and facilities to be upgraded to a faculty of science. Roughly in the same period the magnificent chemical laboratory was reformed (1889–1890, Leitão and Carneiro 2011, p. 125).

An analysis of the architectural morphology of AOLPS buildings reinforces this interpretation. AOLPS was made up of two buildings. One edifice, later known as the 'mathematics edifice', comprising several classrooms, professor's offices and lodging facilities for technical personnel, was constructed adjacent to the wall that divided the upper from the lower ground floor of the botanical garden. The astronomical observatory main building was built on the upper ground floor (Fig. 14.2).

The ground floor level of this edifice was made up principally of two lateral rooms: in the northern room covered with tropical wood was installed a Repsold meridian circle and two pendulum clocks whereas the southern room was a

[35] *Actas do Conselho*, 23 February 1863, liv. 5, pp. 254–255.

[36] In fact, the decision proved to be completely wrong. The observatory building soon presented with serious problems of stability, which got worse when a railway tunnel was opened in the 1880s. The first AOLPS was destroyed and a new one was built in 1898, provided with deeper foundations and far off from the limit of the superior ground of the botanical garden.

Fig. 14.2 The astronomical observatory of the polytechnic

decorated classroom with several ancient instruments and two globes (one celestial and one terrestrial). Other small rooms existed in the ground level. The upper floor was divided into three domes: in the northern dome there was a 6.5" parallatic telescope by Repsold, used to take photos; in the southern dome were installed some portable instruments such as a theodolite by Cooke, and a small transit instrument also by Cooke; a universal instrument by Repsold was also expected. As already mentioned, the central dome was reserved to an 11" photographical equatorial ordered from Alvan Clark, in USA (Escola Politécnica 1878, pp. 41–45).[37]

This morphology of AOLPS is highly symbolic. It was clearly based upon the architecture of research observatories. Nineteenth-century astronomical observatories devoted to meridian work were built according a precise model, basically that of the Observatory of Pulkovo (Krisciunas 1988, pp. 99–119; Raposo 2010; Werrett 2010). The ideal observatory would consist of two lateral parts, west and east, united by corridors to a central part of the building. The central building was to support the grand dome, where the most powerful telescope would be installed. In the lateral buildings of the observatory would be placed the instruments that were used

[37] A coeval description of AOLPS can also be found at the newspaper *Occidente*, 5, 118 (1 April 1882), pp. 74–75.

for determination of the fundamental coordinates of reference stars, namely absolute right ascensions (transit instrument) and absolute declinations (vertical circle), the differential stellar coordinates (meridian circle) and the aberration and nutation (prime vertical instrument). This basic model of meridian observatory could be found in observatories such as the Observatory of Pulkovo and AOL.

AOLPS relied heavily on this model. Although much smaller than the national observatories, it also comprised three parts, serving the central part as the base to the principal dome. Inspired in the ideal research observatory, in AOLPS's building a lateral room was reserved for the transit instrument. It seems that although the observatory was intended to carry out research in astrophysics and astronomical photography, its architecture preserved the physical organization of traditional and more accomplished observatories. Yet, quite surprisingly, AOLPS also included a sumptuous classroom in the main building. It replicated the meridian room. Probably there was no need for more classrooms as there were plenty of them in the 'mathematics building'. Nevertheless, because of its sumptuous character and especially due to its place, replicating the meridian room, it provided the AOLPS main building with symbolic value. It was a teaching observatory as well as a research observatory. Definitely, an important facility for an institution that contemplated university status.

14.5 The Difficulty of Launching a Research Programme in a Peripheral Country

Some years ago Vasco Rivotti Silva included in his M.Sc. dissertation a letter written by a student of LPS at the beginning of the 1917/1918 academic year.[38] Since then, this document has been used to demonstrate that LPS failed to update astronomical teaching and to introduce a research agenda on astrophysics.[39] Writing to his parents, the student revealed the weaknesses of AOLPS: "It is a beautiful building, pleasant to stay and work [in], [but] with several faults which [the] professors are trying to repair. I was told that they are planning to modify one of the more important instruments of the observatory, a German-made telescope that is mounted in the grand dome. […] The professor, whose name is actually Andreia, as father has told, is deeply doubtful that something can be done because of the war" (Silva 1996, Documento 17_10_14).

Unfortunately, Silva did not identify the student. Yet, he was most likely a student who enlisted at LPS in order to pursue a career in engineering. Even after being transformed into the Faculty of Sciences of the University of Lisbon, this institution of higher education continued to be concerned, by and large, with providing preliminary education in science to prospective engineers, military officers and students

[38] Silva (1996, Documento 17_10_14). According to Rivotti, this letter was preserved in a particular collection, whose owner he thanks but does not identify.

[39] For example, Bonifácio (2009, p. 343).

of medical and pharmaceutical schools. This educational goal constrained the rise of research practices at the LPS.[40] Astronomy is a case in point. An observatory was built; it was provided with instruments in some way fitted to astrophysics; a member of its academic staff was able to study abroad. Nevertheless, taking into account the courses they were responsible for, professors were compelled to teach especially the applications of astronomy, relating it with geodesy. Spherical astronomy was thus the central part of the course delivered by professors of LPS and Faculty of Sciences, from Mariano Cirilo de Carvalho (18-) to Pedro José da Cunha (see syllabus in Andreia 1937, pp. 24–27), who, being responsible for teaching astronomy from 1901 to 1914, was considered to have developed the astrophysics contents (Andreia 1937, p. 24). Even Eduardo Ismael Andreia, who taught astronomy for more than two decades at the Faculty of Science (1914–1937), trained his students basically in spherical astronomy (Andreia 1915–1916, 1922–1923, 1934–1935). In conclusion, in a context where faculties of science were supposed to provide applied education to students and prospective civil servants, there was very little room to implement an educational policy based upon research.

This seems to be a feature typical of countries of the European periphery. Portuguese private entrepreneurship was weak and very much dependent on State initiative. Thus, economical demands were not strong enough to shape technoscientific teaching and scientific research. In this context, it is no surprise that scientific professions scarcely existed in the country. As far as astronomy was concerned, apart from the teaching posts at the university observatories of Lisbon, Coimbra and Porto, there was only one research astronomical observatory, the AOL, which means that there were almost no professional opportunities for someone who decided to embark on a career in astrophysics.

It was thus not totally surprising that, in 1933, the government decided to put an end to AOLPS (now Astronomical Observatory of the Faculty of Science) as an autonomous institution, ordering the rector of the University of Lisbon, Pedro José da Cunha, to do so.[41] This observatory would be integrated in the mathematical department. Having been created in close relationship with the launching of a research programme based upon astrophysics, to which mathematicians, physicians and chemists could contribute, the AOLPS ended by being incorporated into a university mathematical department.

Conclusion

The establishment of AOLPS, which occurred in the 1870s and was closely associated with the launching of an astrophysics research programme was part of a strategy carried out by the academic staff of LPS in order to emphasize the academic

[40] This topic is analysed at length in the chapter 'Da Escola Politécnica e da Faculdade de Ciências de Lisboa. Construções identitárias e culturas científicas' by Simões et al. (2013).

[41] Actas do Conselho Escolar da Faculdade de Ciências, AH-MNHNC, 21 July 1933, lv. 7, pp. 6–7.

prestige of their institution. Aiming to be upgraded to a faculty of sciences, the building of an astronomical observatory, as well as the reformation of the chemical laboratory and other teaching and scientific institutes, would demonstrate that LPS was provided with adequate conditions and facilities to be recognized as a university. This reason explained why the astronomical observatory was built in LPS's botanical garden, where no satisfactory physical conditions existed. In the aftermath of the Republican revolution, LPS succeeded in being transformed into a university faculty of science. Yet, the main educational role of this institution remained the same, that is to say, to provide preliminary education in science to prospective civil servants, especially engineers, military officers and to students of medical schools. In this context, there was little room to implement an educational policy based upon research. As a result, very little work was ultimately accomplished in astrophysics by AOLPS during the first decades of the twentieth century.

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References

Actas do Conselho da Escola Politécnica de Lisboa, Arquivo Histórico do Museu Nacional de História Natural e da Ciência, 7 vols.

Actas do Conselho Escolar da Faculdade de Ciências, liv. 7. 1878–1900 Arquivo Histórico do Museu Nacional de História Natural e da Ciência.

Andreia, Eduardo Ismael. 1915–1916. *Curso de astronomia*. Lisboa: Faculdade de Ciências (Biblioteca do Museu Nacional de História Natural e da Ciência).

Andreia, Eduardo Ismael. 1922–1923. *Curso de astronomia e geodesia*. Lisboa: Faculdade de Ciências (Biblioteca do Museu Nacional de História Natural e da Ciência).

Andreia, Eduardo Ismael. 1934–1935. *Astronomia*. Lisboa: Faculdade de Ciências (Biblioteca do Museu Nacional de História Natural e da Ciência).

Andreia, Eduardo Ismael. 1937. *Escola Politécnica de Lisboa. A IV cadeira e seus professores*. Lisbon: Faculdade de Ciências da Universidade de Lisboa.

Aubin, David, Charlotte Bigg, and H. Otto Sibum, eds. 2010a. *The heavens on earth. Observatories and astronomy in nineteenth-century science and culture*. Durham: Duke University Press.

Aubin, David, Charlotte Bigg, and H. Otto Sibum. 2010b. Introduction: Observatory techniques in nineteenth-century science and society. In *Observatories and astronomy in nineteenth-century science and culture,* eds. David Aubin, Charlotte Bigg, and H. Otto Sibum, 1–32. Durham: Duke University Press.

Bennett, Jim. 1987. *The divided circle. A history of instruments for astronomy, navigation and surveying*. Oxford: Phaidon.

Bonifácio, Vítor. 2009. *Da astronomia à astrofísica. A perspectiva portuguesa, 1850–1940*. Ph.D. dissertation, Universidade de Aveiro.

Brandão, Mário and M. Lopes de Almeida. 1937. *A Universidade de Coimbra. Esboço da sua história*. Coimbra: Universidade de Coimbra.

Brünnow, Franz. 1865. *Spherical astronomy*. London: Asher and company.

Carolino, Luís Miguel. 2011. O Observatório Astronómico da Escola Politécnica de Lisboa, 1875–1911. In *Património da Universidade de Lisboa—Ciência e Arte,* eds. Marta C. Lourenço and Maria João Neto, 107–120. Lisbon: Universidade de Lisboa/Edições Tinta-da-China.

Carolino, Luís Miguel. 2012. Measuring the heavens to rule the territory: Filipe Folque, the teaching of astronomy at the Lisbon Polytechnic School and the modernization of the State apparatus in nineteenth century Portugal. *Science and Education* 21:109–133.

Carolino, Luís Miguel, and Ana Simões. 2012. The eclipse, the astronomer and his audience: Frederico Oom and the total solar eclipse of 28 May 1900 in Portugal. *Annals of Science* 69:215–238.

Carvalho, Mariano [Cirilo]. n.d. 1890s. *Lições de astronomia da Escola Politécnica de Lisboa*. Lisbon: Escola Politécnica de Lisboa. Biblioteca do Museu Nacional de História Natural e da Ciência.

Carvalho, Rómulo. 1986. *História do ensino em Portugal. Desde a fundaçãoo da nacionalidade até o fim do regime de Salazar-Caetano*. Lisbon: Fundação Calouste Gulbenkian.

Chauvenet, William. 1863. *A manual of spherical and practical astronomy*. Philadelphia: JB Lippincott Company.

Collecção de Leis e Outros Documentos Officiaes publicados no 1º semestre de. 1837. 1837. Lisbon: Imprensa Nacional.

Corvo, João de Andrade. 1866. *A Instrucção Publica. Discurso Pronunciado nas Sessões de 9, 10 e 11 Abril de 1866*. Lisbon: Typ. da Sociedade Typographica Franco-Portugueza.

Cunha, Pedro José da. 1937. *A Escola Politécnica de Lisboa. Breve Notícia Histórica*. Lisbon: Faculdade de Ciências.

Escola Politécnica. 1878. *Escola Polytechnica 1877–1878*. Lisbon: Imprensa Nacional.

Fernandes, Paulo Jorge. 2010. *Mariano Cirilo de Carvalho. O "poder oculto" do liberalismo progressista (1876–1892)*. Lisbon: Edições da Assembleia da República/Texto Editor.

Folque, Filipe. 1840. *Elementos d'Astronomia coordenados para uso dos alumnos da Eschola Polytechnica*. Lisbon: Na Lithografia da Escola Polytechnica.

Folque, Filipe. 1866. *Relatório acerca do Observatório Astronómico de Marinha*. Lisbon: Imprensa Nacional.

Hutchins, Roger. 2008. *British university observatories, 1772–1939*. Aldershot: Ashgate.

Krisciunas, Kevin. 1988. *Astronomical centers of the world*. Cambridge: Cambridge University Press.

Lamy, Jérôme, and Yves, Gingras. 2008. The relationships between astronomical observatories and universities in nineteenth-century France. *History of Universities* 23:67–108.

Lankford, John. 1997. *American astronomy. Community, careers and power, 1859–1940*. Chicago: Chicago University Press.

Leitão, Vanda and Ana Carneiro. 2011. O *Laboratorio Chimico* da Escola Politécnica de Lisboa, 1837–1890. In *Património da Universidade de Lisboa—Ciência e Arte,* eds. Marta C. Lourenço and Maria João Neto, 121–136. Lisbon: Universidade de Lisboa/Edições Tinta-da-China.

Main, Robert. 1863. *Practical and spherical astronomy*. Cambridge: Deighton.

Newcomb, Simon, and Edward S. Holden. 1889. *Astronomy for high schools and colleges*. 6th ed. revised. New York: Henry Holt and Company.

Oom, Frederico Augusto. 1875. *Considerações acerca da organisação do Real Observatório Astronómico de Lisboa*. Lisbon: Imprensa Nacional.

Raposo, Pedro. 2009. The material culture of nineteenth-century astrometry, its circulation and heritage at the Astronomical Observatory of Lisbon. In *Cultural heritage of astronomical observatories. From classical astronomy to modern astrophysics*. Proceedings of the International ICOMOS Symposium in Hamburg, 14–17 October 2008, ed. Gudrun Wolfschmidt, 99–113. Berlin: hendrik-Bässler-Verlag.

Raposo, Pedro. 2010. *Polity, precision and the stellar heavens: The royal astronomical observatory of Lisbon (1857–1910)*. Ph.D. dissertation, University of Oxford.

Raposo, Pedro. 2011. Observatório Astronómico de Lisboa: um observatório nacional na universidade. In *Património da Universidade de Lisboa—Ciência e Arte,* eds. Marta C. Lourenço and Maria João Neto, 97–106. Lisbon: Universidade de Lisboa/Edições Tinta-da-China.

Reis, António Estácio dos. 2009. *Observatório Real da Marinha*. Lisbon: CTT Correios de Portugal.
Rivotti, V., and A. Sepúlveda, 1987. Astronomia e engenharia geográfica na Escola Politécnica e Faculdade de Ciências. In *Faculdade de Ciências da Universidade de Lisboa. Passado/Presente, perspectivas futuras,* eds. Fernando Bragança Gil and Maria Graça Canelhas, 179–185. Lisbon: Faculdade de Ciências da Universidade de Lisboa.
Ruiz-Castell, Pedro. 2008. *Astronomy and astrophysics in Spain (1850–1914)*. Newcastle: Cambridge Scholars Publishing.
Silva, Vasco Rivotti. 1996. *Do antigo observatório astronómico da Escola Politécnica e da sua musealização*. M. Phil. dissertation, Universidade de Lisboa, 3 voll.
Silva, Vasco Rivotti. 1998. L'Observatoire Astronomique de l'École Polytechnique. In *Museums of science and technology*, ed. Maria Alzira Almoster Ferreira and José Francisco Rodrigues, 125–130. Lisboa: Fundação Oriente.
Simões, Ana, Ana Carneiro, Maria Paula Diogo, and Luís Miguel Carolino. 2013. Da Escola Politécnica e da Faculdade de Ciências de Lisboa. In *A Universidade de Lisboa nos séculos XIX e XX*. 2 vols. 779–859. Lisbon: Edições Tinta-da-China.
Universidade(s). 1991. *História, memória, perspectivas. Actas do Congresso de História da Universidade*. Coimbra, Comissão organizadora do congresso "História da Universiade". 5 vols.
Werrett, Simon. 2010. The astronomical capital of the world: Pulkovo observatory in the Russia of Tsar Nicholas I. In *Observatories and astronomy in nineteenth-century science and culture,* eds. David Aubin, Charlotte Bigg, and H. Otto Sibum, 33–57. Durham: Duke University Press.

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Chapter 15
The Political and Cultural Revolution of the CNRS: An Attempt at the Systematic Organisation of Research in Opposition to "the Academic Spirit"

Robert Belot

15.1 Introduction

In France every war has led to a major rethink of the role of the universities and the mission of scientists as part of the development of political and civic thinking. This was true in 1871, 1914 and 1939. On each occasion, the state rediscovered the dual nature of scientific research as a vector of both knowledge and power, and considered how science could be made to contribute to the nation's war effort. On each occasion, debates emerged around improving the relationships between science technology and industry, the efficacy of research bodies and the links between the universities and research.

During the First World War, these debates took place within the *Académie des sciences* (Academy of Science). They focused primarily on the mission of scientists and the organisation of French research, but also considered the relationship between academic knowledge and its applications—science and technology. Concrete proposals were drawn up to ensure that state-funded research would respond better to the needs of the nation and be more closely linked to research in the private sector. This led to the foundation within the Academy (in other words outside the universities) of a new body intended to support these aims: the *Division des Applications des sciences à l'industrie* (Division of the Application of Science to Industry). After the war, the strength of pacifist feeling among scientific stakeholders hindered the development of this approach and prevented any durable reorganisation plans from taking shape. There was an observable divergence at this time between "technocratic" movements arguing in favour of "techno-science" and the academic world, which tended to retreat into the myth of "pure science".

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The mid-1930s brought a sudden change. The rise of the Nazis to power provoked an anti-fascist reaction in intellectual circles in France, putting an end to the wave of pacifism. The issue of the political utility of science re-emerged as a core concern for the academic world and generated new awareness among political decision-makers. Symbolic of this new understanding of the urgent need to reform research provision and the universities was the creation of the first state secretariat for research in 1936, following the election of the government of the Popular Front. A reform movement was launched and took some major decisions, the most decisive and lasting of them being the creation of the *Centre national de la recherche scientifique* (National Centre for Scientific Research: CNRS) in 1939.

Analysis of this policy over the medium term reveals that, in the inter-war period, the reform proposals primarily involved the creation of independent research bodies unconnected to the universities (designed without input from and even in opposition to the universities). This reveals the explicit or implicit presence of a negative vision of the French university tradition, its practices and culture of independence. It also reveals the emergence of a new set of contrary values tending towards closer links with the state and legitimising the role of politicians, in which the question of the functional efficacy of science became important. This new "research culture", as it can be termed, was not challenged under the Vichy regime and triumphed at the Liberation. So the new French research landscape, which took shape and became durably established in a context of relative consensus, was marked by a radical split between the independent research bodies and the universities, to the detriment of the latter, ultimately widening the gap between science and its applications. It is this French paradox that I should like to examine here.

15.2 Rethinking the Role of Science and the Organisation of Research in France After the First World War

The seminal idea of a precursor to the CNRS emerged in the Academy of Science during the First World War. A debate began around two issues: the relations between "pure" and "applied" science, and the need for better coordination and mobilization of academic research.

15.2.1 The "Sword and the Test-Tube": Rethinking the French Research System

During the war, like all other sectors of society, the Academy of Science was required to join the war effort and make its contribution. While some scientists were fighting at the Front, others were considering how to reform the French research system to make science more able to respond to the needs of the nation.

The academy began a major rethink of the role and utility of science in French industry and the specifically French cultural barriers separating science and industry. This war had two new dimensions that made it quite unlike those that had preceded it: it was total (mobilising the entire country, both the society and the economy) and chemical. Its specifically technological dimension involved politicians, scientists and industrialists alike. The idea dawned that war was no longer a matter for soldiers alone, but also for scientists and engineers, given that "the scientific worker is also a soldier" (Fox 1984, p. 109).

France found itself obliged to produce a massive quantity of arms, leading to questions of how to redesign the production apparatus to improve its responsiveness and capacity for innovation. There was a new understanding of organisation as a science (Le Chatelier). Engineers were going into business (Citroën, Renault, Peugeot) and also, like Louis Loucheur, joining the state apparatus.

The use of chemical weapons had two major consequences, which long affected the relationship between science and war. These were the technologisation and industrialisation of war; chemicals needed to be produced fast and in great quantities. This sudden incursion of science into politics (and comparisons with the German model) led to a new awareness of the need to link "pure" science more effectively to its technological and industrial applications. It became apparent that an institutional process was required to recognise scientific applications (Crosland 1992, p. 425).[1] In this regard 1915 is a symbolic date, being the year when Paul Painlevé, the *Ministre de l'Instruction publique* (Minister of public instruction), renamed his department the *ministère de l'Instruction publique et Inventions intéressant la Défense nationale* (Ministry of Public Instruction and Inventions of Importance for National Defence). December 1916 saw the creation of a *sous-secrétariat d'Etat des Inventions, des Études et des Expériences* (State undersecretariat for inventions, studies and experiments). This was the first time that the French government had turned its attention to organising applied research.

The matter was put before the Academy of Science. Committees on mechanics, physics, health and chemistry were set up within this old institution. The chemistry committee included two great chemists who opened up the debate on the place of science in France: Henry Le Chatelier, a graduate of the *École polytechnique*, and Charles Moureu (former professor at the *École supérieure de pharmacie*, professor at the *Collège de France* and member of the *Académie de médecine*) (Moureu 1979). Some laboratories worked on gas, notably the Municipal Laboratory in Paris.[2]

[1] On the eve of the war this sanctuary of science seemed more dominated by "conservatism", combined with a reticence in regard to new ideas and a tendency to retreat into fundamentalism.

[2] The most important laboratories included the Laboratoire municipal de Paris; the Sorbonne (Professor Grignard was asked to evaluate the analyses of the Municipal Laboratory); the *Ecole supérieure de Pharmacie* (Professor Paul Lebeau); the *Collège de France* (Professor Mayer); the Faculty of Medicine (Professeur Achard).

15.2.2 *Mutual Contempt Between Industrialists and Scientists (Academic Versus Industrial Culture)*

The Academy's war effort involved considering the French research system and its relations with industry. Traces of these investigations can be seen in the reports of the Academy's "secret committees."

The tone was set by academician Henry Le Chatelier, a chemist with interests in metallurgy who always stressed the importance of experimental rather than purely theoretical approaches in science (Gillispie 1981, p. 116). In his application for the Chair of Chemistry at the *École polytechnique* in 1884, he asked to be excused for having produced research "foreign to the field of pure science". He was one of the first to open up public discussion of "the role of industrial concerns in pure science research". In a memoir of 1901 he explains that his goal is to "combat the feeling, now widespread in France, that pure science must eschew any concern with practical applications, that it must isolate itself from industry as from a compromising promiscuity" (Le Chatelier 1969, p. 148). It was he who discovered the managerial ideas of the American engineer F.W. Taylor and introduced them to France, seeking to spread them within the Academy. He wanted to know how the Academy could leave behind its ethereal "purity" and take account of reality: "The Academy should not confine itself to research in *pure* science, but should be concerned with questions of *applied* science. We allowed ourselves to be beaten by Germany before the war; we shall not, now that the war is over, allow ourselves to be overtaken by Britain, whose scientific societies and government have already set to work" (Le Chatelier 1925, p. 116).[3]

The example of Germany made it possible to highlight another fundamental weakness in the French system. According to Le Chatelier, France was "behind the Germans" in terms of the industrial "use" of its discoveries. In his view, Germany's superiority was "crushing", firstly because, unlike France, Germany had developed high-quality technical education that was socially valued. In Le Chatelier's view, contempt for all that was technical in France stemmed from a dominant culture in which "work is still regarded as degrading". Secondly, German scientists did not have a "fundamentalist" conception of science and thought it natural to work in industrial laboratories. This was not without its disadvantages, as identified by the physicist Pierre Duhem, in whose view Germany had encased "the fecund breast of science in a corset of iron" (Prochasson and Rasmussen 1996, p. 210). But for Le Chatelier, it was an example to be followed, since France had almost no industrial laboratories for research and development (Belot 2002, p. 290).[4]

Le Chatelier's diagnosis criticises all the protagonists in the relationship between science and industry. On the one hand are the industrialists who "scorn science" and who, when they have laboratories, do not allow their researchers to publish the results of their work; on the other are the scientific community who look with contempt and disdain on scientists who venture into the territory of industry. "Working with

[3] He has invented the concept of "science industrielle".

[4] According to the mathematician Emile Picard, "science is becoming a means of domination for our neighbours": Speech to the AFAS, 28 October 1916.

industry discredits a scientist" agrees the academician Arsène d'Arsonval, citing an anecdote: "Mr Jamin, who wanted to work on a subject related to electric lighting, was forbidden by the Dean of the Faculty of Sciences from studying it in his laboratory at the Sorbonne".

15.2.3 The Creation of a Division for the Industrial Applications of Science[5]

In 1917 these considerations led to the idea of creating a "division for the industrial applications of science" (*Division des Applications de la science à l'industrie*) (Belot 2000, p. 424) within the Academy. The division was officially inaugurated on 14 January 1918. Its members had the status of "free" academicians, in other words non-resident and without voting rights, and were tasked with establishing "contact between industry and the Academy". It had been accepted in principle that, rather than inviting representatives of the various industries into its midst, the Academy would call on "scientists who had carried out industrial work and helped to introduce scientific methods into industry."

So it was that into the Academy by the back door came: Maurice Leblanc, inventor of refrigerators (later replaced by the concrete specialist Charles Rabut, replaced in his turn by the aerodynamicist Léon Guillet); the metallurgist Georges Charpy; turbine specialist Auguste Rateau, replaced in 1930 by Jean Rey (thermodynamics); Louis Lumière (the cinematograph and colour photography using autochrome plates); Maxime Laubeuf, who built the first submarine; Henri de Chardonnet (inventor of artificial silk) who, after his death in 1924, was replaced by Georges Claude, graduate of the *École de physique et de chimie industrielles de la Ville de Paris* (where Pierre Curie taught), who was familiar with the world of industry (he had been head of scientific research at the Compagnie française Thomson-Houston 1896–1902 before joining the Air Liquide company) and was known as a populariser of science (in 1902 he published *L'électricité à la portée de tout le monde*).

15.2.4 The Dream of a "Great National Laboratory"

Another important and prophetic proposal emerged from these debates, heralding the creation of the CNRS. The starting point was the observation that "all the great industrial nations, with the exception of France, have national laboratories for scientific research", which were attaining critical mass in terms of methods and

[5] The division was closed in 1976, 4 years after the creation of the first French University of Technology. It was reborn in 1982 as *Conseil pour les Applications de l'Académie des Sciences* (CADAS: Council for the Applications of the Academy of Sciences), of Compiègne headed by Michel Lavalou who was the second director of the University of Technology of Compiègne. Michel Lavalou, address of 5 January 1998, in Académie des sciences de l'Institut de France, vol. I, 1997–1998, p. 77.

results. The Academy thought it desirable to establish a "National Scientific Research Laboratory" in France. This project reflected a desire to bring researchers and their research into a common fold and expressed the feeling, widespread at the time, that the basis on which academic research was conducted in France was too individualistic and cut-off from reality. The idea was to organise the work of researchers "systematically", with a focus on experimental methods. Nothing more can be said more about this project as the secret minutes of the Academy tell us very little.

But, before bringing existing research under the same umbrella, there were ideas for new laboratories. The academician Armand Gautier proposed that the activity of these laboratories should be directly attuned to "national needs". He recommended founding three: a central office for agricultural studies and information (*Office central d'études et des renseignements agricoles*), a central laboratory for studies on issues of hygiene and public well-being (*Laboratoire central d'études sur les questions d'hygiène et de bien-être public*), and a national laboratory for chemical study and research (*Laboratoire national d'études et recherche chimiques*). The idea of the chemistry laboratory was symptomatic of the role of the First World War in "triggering" both the professionalisation of chemistry in France and a fundamental transformation of the chemical industry due to the massive production of various products that led to the development of new businesses. Meanwhile the *Laboratoire de Physique et de Mécanique* (Laboratory of Physics and Mechanics) was established under the control of the Academy, with "pure and applied scientific research" as its primary mission.

This concern to bring science and industry together, to group the research offer and involve the state in the process gave rise, in 1922, to the national office of scientific and industrial research and inventions (*Office national de recherches scientifiques et industrielles et des inventions*: ONRSI), an avatar of the former state undersecretariat for inventions, studies and experiments. The idea came from scientist and politician Paul Painlevé, in whose view, "science will play the same dominant role in peace time that it played during the war". The ONRSI was a public sector institution attached to the ministry of public instruction. Its first director, in post until 1938, was the senator Jules-Louis Le Breton, who was secretary of state for inventions related to national defence (1916–1917). Jean Perrin, who would later play a major part in the creation of the CNRS, was also a member, as was Henry Le Chatelier. The ONRSI instigated the creation of two important laboratories at a location called "Bellevue" in Meudon. These were the Academy of Science's large electromagnet (Aimé Cotton), inaugurated in 1928, and the low temperatures laboratory. The ONRSI was part-funded by grants, the selling of patents and profits from the *Salon des arts ménagers* (Home-making exhibition), which had first opened in 1923. Its founder, Jules-Louis Le Breton, was primarily an inventor whose greatest success seems to have been a patent for a washing machine. Both laboratories would later be absorbed by the CNRS (Guthleben 2011).

Conspicuous by their absence in the great national debate on the future of research were the universities. Their non-involvement was a matter of implicit consensus. It seemed that salvation could come only from the creation of new institutions specifically dedicated to research. The relationship between higher education and research was not considered at all. The rise of the CNRS can be understood only in the light of this persistent attitude.

15.3 The Inter-war Period: A New Conception of Scientific Work

The search for ways to strengthen French research continued into the inter-war period, and the action proposed generally ignored the universities. The context was radically transformed by three new factors: the economic crisis, a growing awareness of the threat posed by Nazism, and the rise to power of a new political majority (the Popular Front elected in 1936), which sought to turn research into a public policy tool in order to better mobilise the country's resources (Pinault 2006). The context of emergency led to further marginalisation of the universities and a conception of research focused on functional goals. The frontier between "pure" and "applied" science became blurred, and with it the hierarchy reflected by the distinction.

15.3.1 Defending Scientific Research

However, the period immediately after the First World War had been dominated by fears of a crisis in the numbers of scientists. These fears were linked to the importance of research in the development of the nation, on which all were agreed, and also to the risk represented by a dynamic industrial sector (a reality in the 1920s) that might attract researchers and engineers.

In his closing address as president of the Academy on 12 December 1921, Georges Lemoine, graduate of the *École Polytechnique*, engineer and chemist, gave "a cry of alarm concerning the dwindling numbers of true scientific vocations" and the recruitment crisis among "the elite represented by disinterested researchers". "Since peace has been restored, the number of these true friends of science seems unusually diminished. Many young people in whom we might have placed some hope have rushed into industry, neglecting even the honourable and brilliant careers offered them by the state. The rise in the price of everything may explain this situation, but it cannot justify it." At a time when grant-awarding bodies were few and far between (École normales supérieures, universities, Collège de France, Muséum d'histoire naturelle, École des hautes études), he dreamt of keeping young researchers in incubators, on the model of the Fondation Thiers. In Lemoine's view, the younger generations were influenced by "more or less materialistic trends", and the younger generation agreed. In 1944 Frédéric Joliot-Curie identified the cause: "If the salaries of sciences and professors were higher, they would undoubtedly give free advice, not just to the particular industry that paid them, but to everybody"[6] (Nicault and Durand 2005, p. 271).

[6] Minutes of the management committee meeting of 18 September 1944.

A new generation within the Academy seemed to be moving in the opposite direction from the understanding that had led to the creation of the division for the industrial applications of science. In 1927 the Academy's president Charles Barrois, who supported the notion of "pure science", expressed this alternative view: "And in these times when international science is dazzling the crowds and transforming civilisation with its applications, France retains both her pre-eminent position in the modern production of energy and in *the development of pure science*, the science that may perhaps profit only our grandchildren, but without which no further decisive steps can be taken."[7]

This need to assert the importance of science was primarily associated with the emergence of "anti-science prejudice" (Eidelman 1986, p. 113). The economic crisis of the 1930s and its attendant political crisis (linked to the emergence of a radical critique of democracy) led to criticisms of science, which was accused of having given birth to a civilisation of machines that killed human work. Academy president Émile Borel, who signed the Petition of March 1933, alludes to this in 1934: "It is remarkable, and could even be regarded as paradoxical, that the systematic organisation of scientific research is being implemented in France at a time when some distinguished minds are casting doubt on both the hitherto undisputed human importance of Science and its applications. […] Some have maintained that *Science is largely responsible for the crisis and that unemployment and poverty are due to advances in the use of machines, and some have even gone so far as to recommend that inventors should take a break.* Why not put scientists and laboratories to sleep?"[8]

This defence of science also seems to reflect a new split that emerged within the Academy with the atomist revolution, symbolised by Jean Perrin, whose book *Les Atomes* was published in 1913. The atom introduced a new political paradigm into the Academy, leading to an internal split and a notable increase in papers on radioactivity: 3 in 1919; 23 in 1928; 55 in 1932. Jean Perrin and the partisans of "intuition", who supported the new atomist theories and advocated research into the unknown, contrasted with the "inductivists", who criticize hese theories, including Le Chatelier, who said, "they are not discoveries" (1925). Georges Claude favoured "the experimental study of facts without theories".

This split was overlaid by another around conceptions of scientific creativity.

In Perrin's view research was not a matter of individual genius but *collective organisation*. Researchers were like "clerks"—what counted was not results, which "could play into the hands of the worst forms of immorality", but method, "which teaches the exercise of reason disdaining all practical importance". For Perrin, the approach through genius led only to anarchy. Joliot was of the view that Archimedes and Newton had "wreaked havoc in the minds of scientists". They had provided "fallacious" arguments to those who believed that "discovery is born of fantasy" and were thus "rebels against any kind of organisation" (Laugier 1944, p. 7). The younger generation of researchers wanted to challenge the heroic, romantic view of researchers. But this conception was not shared by all. One of its key opponents was

[7] Académie des Sciences, session of 4 January 1927, p. 20.

[8] Académie des Sciences, session of 3 January 1934, vol. 198, p. 19.

appointed to the division of industrial applications of science. Whereas, in Perrin's view, science needed collective organisation, Georges Claude preferred to believe in chance and the "light that suddenly illuminates an overexcited brain": "What inventors do is to perceive unexpected relationships between things that are unrelated, that come to them from we know not from where, through some kind of cerebral short circuiting—a way of refreshing the disrespectful thesis that sees inventors as simply crackbrained" (Claude 1957, p. 101). This conceptual split often coincided with a political division: Perrin was resolutely a man of the Left; Claude was on the Right and moved to the extreme Right during the Occupation. Those placing themselves on the Right (Le Chatelier) tended to be of the view that the political class was discredited and the state should not be supporting research. The views of Georges Claude were violently anti-Popular Front. Conversely, Perrin, Langevin, Borel and Cotton, who were on the Left, trusted the politicians and wanted the state to be involved in organising research.

We should, however, qualify this opposition between the supporters of "pure science" and "applied science". Elected to the Academy in 1923 and awarded the Nobel Prize in 1926, Jean Perrin was secretary of state for research in the government of the Popular Front and regarded science as crucial to social and economic progress. For him progress was linked to the rise of "material civilisation", to borrow the term used by the historian Fernand Braudel. In the famous petition he drew up "For scientific research" in March 1933, Perrin recalled that "the disinterested research of pure science has been the source of almost all the great advances in human powers."[9] This constitutes an acceptance that science produces both knowledge and power and that its role is to transform and improve living conditions. Moreover, the signatories include a standard bearer of applied science, Henry Le Chatelier, and members of the division for industrial applications of science, such as Louis Lumière and Charpy. When Joliot established his nuclear research laboratory, he observed that "it is only through close collaboration between technological research, industry and scientific research that we shall bring this project to fruition" (Pinault 2000, p. xxx). On 21 December 1936, in his closing speech as president of the Academy, the Nobel Prize-winning physicist summed up his position as follows, not excluding technological research:

> At first I thought only of *pure research*, which, in addition to any expansion of our intelligence, gave us the extraordinary *increase in power* that is the great fact of contemporary history. It is through pure research alone that we can hope for something truly new that will free all men from servitude of all kinds, so giving them the noble leisure without which there can be no high culture. [...] But, while Research and Discovery can bring about this miracle, it is nevertheless through *the intermediary of Invention and different techniques* (italics ours).

The aim of the *Palais des découvertes* (Palace of discoveries: "Palais des sciences") imagined by Perrin in 1931 and created in 1937, was precisely to combat anti-science prejudice by showing that science is useful and is not dangerous (Ory 1991, p. 190). But it had to be collectively organised in order to serve the nation, and this required state intervention (Nye 1974, p. 143).

[9] Archives nationales (France), F17/17463.

15.3.2 Organising and Professionalising Research Without the Universities

Grouped around Jean Perrin at the Academy were those convinced of the need for a "systematic organisation of scientific research". This organisation would involve the creation of a group of specialised but independent researchers from both industry and education. The aim was to start the process of professionalising research. Jean Perrin was later able to realise this ambition when he became secretary of state for scientific research under the Popular Front (29 September 1936–23 June 1937)[10]. In his view the work of "true" researchers had to meet three criteria: independence; disinterest (general interest); adherence to professional ethics. In 1930 he told the Academy of his project to create a national department of scientific research (*Service national de la recherche scientifique*). His aim was to encourage young people to become researchers, "to permit researchers who have already distinguished themselves to pursue their research without material worries and with no obligations but that of devoting themselves entirely to research", and also to free university teachers[11]. Here again we find the presupposition that research can only be developed outside the university sector.

The *Caisse nationale des sciences* (national fund for science) was established on 16 April 1930 with the role of awarding research grants. The young Frédéric Joliot (1900–1958) was one of its first beneficiaries (Pinault 2000, p. 55). He was one of the young researchers who were prepared to do anything to keep out of the universities and devote themselves entirely to their research. Joliot had nothing but scorn for the universities: their teaching that was "either pretentious or old-fashioned", and the examination giving access to university posts was the "*agrégation*, which stifles our best students to death" (Pinault 2000, p. 100). His home could only be the Collège de France (1936).

In March 1933 Jean Perrin drew up a petition "For scientific research", which received 81 signatures (mostly from members of the Academy) before it was submitted to the authorities. Perrin explained that it was in the nation's "greatest interest" to find gifted researchers, since progress was linked to the development of science. To give science greater visibility, he suggested setting up a *Conseil supérieur de la recherche scientifique* (Higher council of scientific research) divided into eight disciplinary groups and answerable to the minister of education.

His idea was soon put into practice. A decree establishing the higher council of scientific research was published on 7 April 1933. In setting out the reasons for this move, the education minister Anatole de Monzie explained that it was right to do for research what had already been done for education. A *Conseil supérieur de l'Instruction publique* (higher council for public instruction) did indeed already exist, working closely with the minister and watching over the "educational interest".

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[10] Irène Joliot-Curie was the first undersecretary of state for scientific research, from 5 June to 28 September 1938.

[11] Académie des Sciences, session of 30 June 1930, vol. 190, p. 1533.

The new council was intended to create “a high-level consultative body to defend the interests of scientific research” and consisted of representatives of the scientific disciplines, whereas the higher council for public instruction represented scientific institutions. The new council was to suggest reforms necessary to the vitality of French research, to control the financial resources of the various “science funds” that financed the laboratories and to “give an opinion on the use of resources” allotted to research. Concern that this research should be useful is shown in the preamble, where it is stated that the “technical” ministries will be represented in order to create a link “between researchers and those who use the applications of science”. The national fund for scientific research, the *Caisse nationale de la recherche scientifique* (CNRS), was founded 2 years later, on 30 October 1935, grouping together the “science funds” under the aegis of the higher council. Its aim was to fund grants (hitherto left to private sponsors), missions, equipment and publications, and to provide pensions. Of course, controlling funding is a way of directing research. It was planned that the newly established laboratories would be linked to the CNRS. Its first board meeting was chaired by Jean Perrin in 1936.

So laboratories had been created, but they were *outside the universities*, leading to criticisms from academics (Picard 1995, p. 67). In practice the instigators of this major reform had only distant links to the university sector. Jean Perrin had come through the *École normale supérieure*. Joliot trained at the *École supérieure de physique et de chimie industrielles de la ville de Paris*. He had nothing but contempt for the universities. The reformers were convinced that effective research could be conducted only as part of an exclusive group. It required research professionals.

15.3.3 The Popular Front: For “Science Policy” and Against Academic Individualism

On gaining power in 1936, Jean Perrin did all he could to implement his ideas for reforming French research and to impose the new concept of “scientific policy” (Picard and Pradoura 1988, p. 40).

His first aim was to set up a national body that had an overview of French research, so that work could be directed from the top down, by the state, which thus regained control of research activity.

The *Service Central de la Recherche scientifique* (central department of scientific research) was included in the finance law of 31 December 1936 and officially established on 28 April 1937, under the aegis of the education minister. Its remit was to “guide, generate and coordinate all scientific research activities in all fields”. It drafted the budget for scientific research, after consultation with the *Conseil supérieur de la recherche publique* and the *CNRS*. The task was enormous. It was an initiative primarily intended to support the “generalist laboratories of higher education”, in other words the universities, for it was this department that allocated research funds. It also funded the specialised laboratories that were linked to it. But its remit did not extend to funding the many laboratories run by state authorities. It is clear that the model on which it was based was that of the German *Kaiser Wilhelm Gesellschaft* (now Deutsches Forschungs Gesselschaft, DFG, the premier research 'society' or 'company'), established in 1911, which comprised research institutes outside the universities.

The new department was led by Henri Laugier, future head of the CNRS. Laugier held the Chair of the physiology of work at the *Conservatoire national des arts et métiers*, founded in 1928, and was a professor at the Paris Faculty of Science (1935). He was an intellectual activist (in 1930 he founded the Rationalist Union of which Jean Perrin was a member) and, as a member of the cabinet of the education minister Yvon Delbos, also understood the arcane workings of the state apparatus.[12]

Henri Laugier favoured interdisciplinary science and could grasp its practical possibilities. He adopted a scientist tone, suggesting, with Jean Perrin, that science could lead to "a better city". He was an advocate of republican science, a scientist who believed in the role of state stimuli and was not alarmed by the idea that science could be a factor in the development of national power (Paul 1985, p. 3). He asserted this position in a farewell speech of 1968: "Profoundly aware that the power of a nation is founded on the power of its scientific research, I have fought tirelessly to ensure that the public and government understand the high priority that, of all priorities, must be given to national support for scientific research" (Picard 1995, p. 63; Laugier 1955, p. 101). The fight against the Nazi threat gave legitimacy to this "activist" conception of science and the scientist.

Laugier liked to portray himself as a Don Quixote, castigating "academic conservatism" and mocking "the viscosity of state education". He shared Perrin's contempt for the universities: "A tradition of total freedom, frantic fantasy and frenetic individualism in the choice of problems to investigate, reigns supreme in the university laboratories" (Laugier 1942, p. 60). In December 1940 Charles Jacob, appointed as head of the CNRS by Vichy for the duration of the Occupation, similarly deplored "the exaggerated individualism that has nothing to do with true scientific independence". Moreover, Jacob later supported the view that the CNRS should be entirely independent of the universities. At this time France was dominated by "small Chair laboratories", which allocated funds. In 1944, in the *Revue d'Alger*, Laugier noted that the universities were "generally created to meet the needs of teaching" and that academic research was fundamentally linked to a professor, resulting in "research generally chosen in a totally arbitrary fashion, often for reasons of pure chance and covering only a tiny field of knowledge" and often dictated by fashion (Laugier 1944, p. 15). In his own career Laugier had always prioritised research and publications over teaching. This voluntarism and the presuppositions that underlay it naturally aroused fierce opposition. Parliamentarians denounced it as a source of financial waste. Academics were appalled to see Perrin's clan in power. In a note to his minister dated 7 February 1939, Laugier accepts that "criticisms" of the reform "spread through the universities by men who feel little good will towards Jean Perrin […] had helped to create an atmosphere of hostility towards research within the universities.

[12] Six times in the years 1925–1940.

Large budgets were deployed to set up new research laboratories outside the universities, under the aegis of the national fund for scientific research. These included the *Laboratoire des gros traitements chimiques* (major chemical treatments laboratory) headed first by Georges Urbain and then by Georges Chaudron, professor at the Sorbonne; the so-called "atomic synthesis" laboratory headed by Joliot-Curie; the human biometry institute founded in 1937 with funding from the national fund for scientific research and headed by Henri Laugier; the Institute of Nutrition, founded in the same year by André Mayer; and the *Institut de recherche et d'histoire des textes* (Institute for research and textual history) founded by Félix Grat (Guthleben 2009).

15.4 The CNRS: Cultural Revolution and Political Goals

The creation of the CNRS was driven by this desire for reform and by events in the shape of the fascist threat and the shadow of war. Science was put into service, requisitioned to prepare for the mobilisation of the nation. The power it represented was intended for use in the defence of humanist values threatened by Nazism. This necessity led to the irreversible rationalisation and professionalisation of research.

15.4.1 An Instrumental Approach to Science as a Tool in War

As at the time of the Great War, attempts were made to direct scientific work. The debates around "pure" and "applied" science were no longer appropriate. The full potential of French research was to be mobilised in service of the industrial and military war effort. As Joliot-Curie noted on 18 September 1944, "at the moment, science is winning the war" (Blay 2011, p. 13). The Left came to terms with this instrumental approach to science as a tool in war. This is why the "A" of "applied" figured in the first name given to the CNRS. May 1938 saw the creation of the *Centre national de la recherche scientifique appliquée* (CNRSA: National Centre for Applied Research) under the aegis of the Ministry of education.

The idea came from Jean Perrin, but was implemented by the education minister Jean Zay, the radical Member of Parliament for Orléans. In his memoirs Zay recalls what was at stake: "The aim was at last to give our country a permanent body that could encourage, assist and direct researchers; to give them the necessary funds; to unify the research bodies in the perspective of national defence; to organise cooperation between science and industry. […] There was nothing coordinated or homogeneous about the field of applied scientific research" (Zay 1945, p. 268). France, he explained, had institutes and laboratories with a range of affiliations, including higher education, technical education, government departments and ministries, all governed by a spirit of compartmentalisation and jealousy.

The aim was to be part of the revitalisation of "all the productive forces in the country", as the preamble indicates:

> Alongside industrial tools, the training of a specialist workforce and the duration of the work, a crucial factor in production sometimes escapes general notice: research. Considerable, but as yet insufficient efforts have recently been made in favour of pure scientific research. Parallel action must now be undertaken as a matter of urgency in private industry and the technical departments of the state. This is indispensable to both the national economy and national defence.

It was observed that "since the war the research effort has been frankly inadequate. French technology is a long way behind that of a great many nation" (Laugier 1944, p. 26). The project sought to coordinate the research conducted by public sector laboratories, some private laboratories and services run by several ministerial departments, and to liaise with private sector organisations.

The CNRSA replaced the national office for scientific and industrial research and inventions which, if we are to believe Jean Zay, was dozing. The Minister of education encountered violent hostility from its director J.-L. Breton, who tried to rouse the Senate. The CNRSA was given oversight of the Bellevue group of laboratories. It presided over the Higher Commission for inventions. The difference was that it was headed by the *Haut Comité de coordination des recherches scientifiques* (literally, 'high committee for the coordination of scientific research). The Ministry of war was unwilling to cooperate, preferring to retreat behind a wall of secrecy. Industrialists seldom turned to the CNRSA. And yet, as part of its mobilisation mission, it oversaw 174 laboratories with a total of some 1100 personnel (equivalent to 6.3 individuals per laboratory). Its mission was to appoint researchers, allocate grants to the laboratories and set up new laboratories as needed.

To head the CNRSA Jean Zay wanted to appoint someone from neither industry nor the universities, but a person who could reconcile the two cultures. He asked Ernest Mercier, Auguste Deteuf and Raoul Dautry, but without success. He offered the post to Frédéric Surleau, a high-ranking engineer in the Société Nationale des Chemins de Fer (SNCF) but the latter's superiors would not let him go. So Zay was obliged to appoint an academic. The Dean of the Faculty of science in Lyon, the physicist Henri Longchambon, was the ultimate choice. His deputy was Henri Laugier, as noted above then professor in Paris and also head of the Delbos' cabinet (13 September 1939–21 March 1940).

15.4.2 The Centre National de la Recherche Scientifique (CNRS)

A year after the emergence of the CNRSA the realities of war and the desire to group those scientists driving research more closely together led to the creation of the national centre for scientific research, the *Centre national de la recherche scientifique* (CNRS: National Centre for Scientific Research) on 19 October 1939. Its mission was to "facilitate research and work important for national defence and the national economy", in other words to set the scientific war effort in motion.

The CNRS comprised the CNRSA, the *Caisse nationale de la recherche scientifique* (responsible for the fundamental research laboratories), and the national laboratory for scientific research and inventions. It had a “dual mission, in the field of pure research and that of applied research” and was structured in two “sections”: pure research, headed by Laugier, and applied, headed by Longchambon. But it was Laugier who oversaw everything until the armistice of 1940.

The pure research section gave grants for equipping and sometimes building laboratories; funded technical assistants personally attached to some scientists; funded research grants, “particularly for young researchers who need to be encouraged to devote themselves entirely to research”; supported scientific publications and travel; gave temporary assistance to “elderly scientists or scientists in need.”

The applied research section was required to “stimulate, coordinate and encourage applied scientific research, through grants for equipment and allowances”. It was to intervene at the *project* level: “These grants are never made to an institution as a whole, but to a specific research subject, undertaken by a responsible scientist.” The aim, as can be seen from an internal memo, was “to erase the selfish notion of the ownership of a research subject in favour of complete collaboration between competent specialists, the interpenetration of academics and technicians” (Laugier 1944, p. 10). Here we sense one of Perrin’s principle demands: making researchers adopt an approach focused on the common interest and projects, regardless of status and institutional links. It was the university tradition of “small Chair laboratories” that was under attack.

15.4.3 The Vichy Regime: For the CNRS, Against Academic Individualism

When the Vichy regime came to power it presented no challenge to the CNRS. On the contrary, it legitimised and reinforced the logic underpinning its creation.

Laugier and Longchambon disappeared from the organisation (they were fired). The physicist Jean Mercier, Dean of the Faculty of science in Bordeaux, replaced Laugier for a month, long enough to write a report. In this report he explains that he had been hostile to the creation of the CNRS, but admits that familiarity with it has “changed [his] mind”. In his view the CNRS is a happy manifestation of the interest that the government is at last showing in research: “The importance of scientific research is now accepted, whether it be disinterested or serving an immediate goal, whether it seeks to increase our knowledge or to modify our living conditions”. For him, “to come to fruition, technological work can no longer be isolated from scientific work”. He pleads in favour of recognising the value of the “title of doctor-engineer”. Academic though he may be, he accepts that it is time to put an end to “our individualist tendencies”. He even explains that the success of the CNRS involves a break with academic habits: “Indeed in certain cases it will succeed only if it distances itself from the academic spirit. For all these reasons the Centre must remain independent of higher education”. So the CNRS project is given legitimacy as a means of combating the academic system.

Mercier was succeeded by the geologist Charles Jacob on 8 August 1940. Jacob was a member of the Institute and professor at the Faculty of science of the university of Paris. He was also persuaded of the relevance of the CNRS. In his report of December 1940 he lucidly acknowledges: “It is right to recognise that earlier years have, if not created, at least largely developed the budget necessary to encourage scientific research”. Indeed, he went even further, abolishing, on 10 March 1941, the division between the two sections. Like Mercier citing Pasteur and Le Chatelier, he maintained that the separation between the scientific and technological spheres was “more theoretical than real”. He criticised the “pulverisation” of funding (at the time the CNRS had a budget of 3,708,058,372 € and sought to strengthen the project-based approach and improve coordination of the research effort. Like Perrin and Laugier before him, Jacob deplored the lack of an “inventory of the country’s scientific capabilities” and waged war on the counter-productive individualism of the academic tradition: “People, laboratories and, still more, departments are unaware of each other. They are sometimes engaged in the same work, with fragmented and often insufficient funding, demonstrating an exaggerated individualism that has nothing to do with true scientific independence.” Like Mercier, Jacob believed that “the autonomy of the Centre in relation to higher education is justified”. He saw the CNRS as vital to France: “Its name is a flag in itself”. It must be “maintained and developed”.

However, Jacob was unable to prevent the proliferation of autonomous laboratories. The main examples founded under the Occupation were, in 1941, *Institut national d'hygiène* (National hygiene institute: INH), which became Inserm in 1964; Fondation Alexis Carrel, forerunner of the INED; in 1942, *Office de recherches scientifiques coloniales* (Office of colonial scientific research), the future ORSTOM; in 1943, *Institut de recherches sidérurgiques* (Institute of steel research: IRSID), the brainchild of Jean Rist (killed fighting for the Resistance);[13] and in 1944, *Centre national d'études des telecommunications* (CNET: National centre for telecommunications studies).

15.4.4 The Separation Continues in the Post-war

The Liberation, which saw an increased role of the state in moulding economic and social life, did not interrupt this process of creating specialised research bodies. In fact it intensified, despite the fact that the new Director of the CNRS, Joliot-Curie, wanted to implement a real “command” of research, a “vertebrate structure bringing men and things into a network of connections, of command, in relation to action for war or peace and ensuring maximum productivity for all”. The process of creating research bodies moved into the provinces. The future Nobel Prize-winner Professor

[13] This was a professional initiative, primarily on the part of engineers of the Mines corps, to counter the emerging CNRS, which was seeking to create an institute for metallurgical research. It did not truly come into being until 1946.

Louis Neel began his work on magnetism in Strasbourg (Magnetism laboratory), before moving to Grenoble (1940) with his assistants[14]. They worked in the premises of the Institut Fourier at the Grenoble Faculty of science. In 1946, with Louis Neel at their head, they founded the first CNRS laboratory in the provinces: the L.E.P.M. *Laboratoire d'Électrostatique et de Physique du Métal*.

Engineers became central players in institutional research. This marks an intensification of the separation between the universities and specialist research bodies. Independent research bodies proliferated: creation of the *Institut du pétrole, des carburants et des lubrifiants* (oil, fuels and lubricants: 1943), which later became the *Institut français du pétrole* (13 June 1944), later renamed the *Institut du Pétrole et des Énergies Nouvelles* (oil and new energies: IFPEN) by the Grenelle II law 2010; an atomic energy authority, the *Commissariat à l'Énergie Atomique*: CEA), founded on 18 October 1945, the founding of which excluded the CNRS from the nuclear physics field; centres researching cures for cancer (1 October 1945); in 1946 the *Institut national de la recherche agronomique* (INRA: national institute for agronomic research); in 1964 the *Institut national de la santé et de la recherche médicale* (INSERM: national institute for health and medical research); IRIA (Institut de Recherche en Informatique et automatique) later INRIA (Institut national de recherché en informatique et en automatique) in computer science (1967); and IFREMER (Institut Français de recherche pour l'exploration de la mer) 1966).

Conclusion

This wave of new research bodies reflected General de Gaulle's desire to make research serve French strategic interests.[15] But it was also part of a trend that had emerged during the First World War and reveals the strength of "Colbertism" in French political culture. The state sought not only to run the society and economy but also the conditions of research production. This culture triumphed in 1945, notably with the creation of the atomic energy authority (CEA) and the strengthening of the CNRS.

The history of the birth of the CNRS enables us to gain a better understanding of the moment when politicians realised that research was a factor in French power. It was only after the shock of subsequent events that this awareness became more objective and took concrete form in a reshaping of the scientific landscape and a lasting change of practice. Antifascism played a crucial role in developing a greater maturity of understanding. The French scientists who formed the reforming elite were generally on the political Left. Tempted by the pacifism that predominated after the Great War, they were soon persuaded of the need to mobilise science and technology in the struggle against Nazism and the defence of republican values. The

[14] Jacques Mehring, Félix Bertaut and Louis Weil.

[15] Fondation Charles de Gaulle. 2003. *Le général de Gaulle et la recherche scientifique*. Cahier 12.

role of scientists was crucial both in raising awareness among politicians and in the design and implementation of "scientific policy", as symbolised by Perrin.

The birth of the CNRS should also be seen as revealing a revolution in conceptions of science itself and of scientific work. Firstly, though the split between "pure" and "applied" science dominated the language, it was gradually left behind throughout this period and practice did not always reflect the dichotomy, which was more proclaimed than experienced. Knowledge was no longer understood as separate from power. The example was set by those at the top, who were Nobel Prize-winning researchers known for their humanist commitment. The conditions of scientific production were rethought, the figure of the isolated researcher of genius being cast aside in favour of a collective approach where research was developed in the collaborative space of the laboratory, and could thus attract more funding. For the Popular Front also raised the question of finance, which had as its corollary a new awareness of the need to professionalise research and enhance the status of researchers.

Of course, as has been too little noted until now, this attempt at the systematic organisation of scientific research was made in opposition to the "academic spirit". The universities had become an anti-model, being perceived as places governed by individualism, where research was seen as a marginal activity, unrelated to the great issues of the nation. This contempt had very old roots. The French state had always been wary of the universities as seedbeds of turbulence.

Today the landscape of research and higher education in France reflects the cultural and political revolution of the CNRS. It is a peculiarity of the French system that it has so many different institutions: 80 universities, 120 grandes écoles, 20 generalist and specialist bodies. There is no one administration or affiliation. It was not until 1999 that an appendix to the draft finance law was instituted ("Coordinated higher education budget"), which covers all state funding for tertiary education. The universities are only one element among others, whereas in other western countries, such as the USA, they form the hub around which research is structured and on which funding is focused. More than two-thirds of state-funded research is managed by research bodies. With the current ideology of ranking, this dispersal poses a problem for international readability. The French academic world reflects the identity of France, with its permanent tension between the desire for unity and individualistic entropy.

References

Belot, Robert. 2000. Quand l'Académie des sciences découvre la technologie (1915–1919). In *La technologie au risque de l'histoire,* ed. Robert Belot, Michel Cotte and Pierre Lamard, 413–428. Paris: UTBM/Berg International Editeurs.

Belot, Robert. 2002. L'aveu idéologique des vœux de l'AFAS. In *Par la science, pour la patrie. Un projet politique pour une société savante, l'Association française pour l'avancement des sciences (1872–1914),* ed. Hélène Gispert, 287–296. Rennes: Presses Universitaires de Rennes.

Blay, Michel. 2011. *Quand la Recherche était une République. La recherche scientifique à la Libération*. Paris: Armand Colin.

Claude, Georges. 1957. *Ma vie et mes inventions*. Paris: Plon.

Crosland, Maurice. 1992. *Science under control. The French Academy of sciences. 1795–1914*. Cambridge: Cambridge University Press.
Eidelman, Jacqueline. 1986. Science industrielle contre science pure: la professionnalisation de la recherche dans les années trente. In *Les ingénieurs de la Crise,* ed. André Grelon, 113–133. Paris: EHESS.
Fox, Robert. 1984. Science, the university and the state in 19th century France. In *Professions and the French State. 1700–1900,* ed. Gerald L. Geison, 109. Philadelphia: University of Pennsylvania Press.
Gillispie, Charles. 1981. *Dictionary of scientific biography*. vol. 7. New York: Charles Scribners's Sons.
Guthleben, Denis. 2009. *Histoire du CNRS de 1939 à nos jours. Une ambition nationale pour la science*. Paris: Armand Colin.
Guthleben, Denis. 2011. *Rêves de savants*. Paris: Armand Colin.
Laugier, Henri. 1942. How science can win the war. *Free World* 1:55–63.
Laugier, Henri. 1955. *Une puissante recherche scientifique, condition préalable à toute grandeur française,* 148. Paris: Les Cahiers rationalistes.
Laugier, Henri. 1944. Le Centre National de la Recherche Scientifique en France. Revue d'Alger 1:6–20.
Le Chatelier, Henry. 1925. *Science et industrie*. Paris: Flammarion.
Le Chatelier, François. 1969. *Henry Le Chatelier. Un grand savant d'hier. Un précurseur*. Paris: Revue de Métallurgie.
Moureu. 1979. *Index biographique de l'Académie des sciences, 1666–1978*. Paris: Institut de France, Gauthier-Villars.
Nicault, Catherine, and Virginie Durand. 2005. *Histoire documentaire du CNRS. Tome 1 années 1930–1950*. Paris: CNRS Editions.
Nye, Marie-Jo. 1974. Science and socialism: the case of Jean Perrin in the third republic. *French Historical Studies* 9:141–169.
Ory, Pascal. 1991. Une cathédrale pour les temps nouveaux? Le Palais de la Découverte (1934–1940). In *Masses et culture de masse dans les années trente,* ed. Régine Robin, 180–204. Paris: Editions Ouvrières.
Paul, Harry W. 1985. *From Knowledge to power. The rise of the science empire in France, 1860–1939*. Cambridge: Cambridge University Press.
Picard, Emmanuelle. 1995. Henri Laugier et le CNRS (1936-1939). In *Henri Laugier en son siècle*, ed. Jean-Louis, Crémieux-Brilhac and Jean-François, Picard, 67. Paris: CNRS Editions.
Picard, J.-F., and E. Pradoura. 1988. La longue marche vers le CNRS, 1901–1945. *Cahiers pour l'histoire du CNRS* 1:30–47.
Pinault, Michel. 2000. *Frédéric Joliot-Curie*. Paris: Odile Jacob.
Pinault, Michel. 2006. *La science au Parlement. Les débats d'une politique de recherches scientifiques en France*. Paris: CNRS.
Prochasson, Christophe, and Anne, Rasmussen. 1996. *Au nom de la patrie*. Paris: La Découverte.
Zay, Jean. 1945. *Souvenirs et solitude*. Paris: Julliard.

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Chapter 16
Visions of Science: Research at the Faculty of Sciences of the University of Lisbon seen Through its *Journal*

Maria Paula Diogo, Ana Carneiro and Ana Simões

16.1 Introduction

This chapter focuses on the *Journal of the Faculty of Sciences of Lisbon*, created in 1937, taken as an open window to the construction of an institutional identity for this Faculty. The Faculty of Sciences of the University of Lisbon was created, in 1911, in the context of the Republican reform of higher education, which founded the universities of Lisbon and Oporto. Universities were given the mission of promoting scientific research, and the faculties of sciences of teaching the sciences and their applications and fostering the diffusion of a scientific culture in society. The implementation of this reform raised a number of questions and challenged long-held beliefs and traditions in Portuguese academia. In particular, it not only changed the very concepts of scientific research and teaching, but also reversed their relative importance, the former taking precedence over the latter. Scientific research was no longer meant to merely find solutions for immediate problems, but should be pursued independently from short-term interests; scientific teaching, in turn, should be based on practice, be it in the laboratory or in the field. The aim was to establish a research culture within the faculties of sciences by instilling a scientific spirit in both teachers and students. However, this was a complex process because it awakened personal and institutional rivalries, often contaminated by political issues. Promiscuity between State, politics and institutions for higher education, which since

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the eighteenth century had plagued Portuguese academia, swept across the ensuing political regimes—the nineteenth-century Liberal monarchy, the early twentieth-century First Republic and the *Estado Novo* dictatorship (1933–1974)—to such an extent that academic aims often clashed with State policies.

The scientific agendas of the successive political regimes constantly linked science and technology to the idea of progress and modernity, establishing a hierarchy of scientific areas that changed over time, always promoting some to the detriment of others. Choices depended heavily on State priorities and the lobbying capacity of scientists. In the 1950s, the importance bestowed on nuclear energy came to involve various scientific areas and united State and university interests, constituting a fine example of this complex web of projects and influences.

In the 1930s and 1940s, societies of different scientific disciplines emerged as a result of the creation of the faculties of sciences in 1911. Together with the faculties, universities and university institutes, they began publishing scientific journals and publications devoted to the popularization of science, in this way generating a publishing movement in which the various journals were exchanged between institutions, nationally and internationally, becoming a common currency. The *Journal of the Faculty of Sciences* is a paradigmatic example of this movement, and is used in this chapter as an exploratory device to show how scientific research was selected as the central piece in the construction of the identity of the institution. As such, the *Journal* emerged as an instrument to affirm scientific research not only within the Faculty but also outside, both nationally and internationally, in this way encouraging the internationalization of scientific research carried out in the Faculty of Sciences of Lisbon, a goal which was perceived differently by distinct scientific areas and scientists.

16.2 Sciences in Universities and Higher Education Institutions

For almost four centuries, the University of Coimbra was the only lay university in Portugal. The then called General Studies had been founded in 1290, encompassing the Faculties of Arts, Canon Law, Civil Law and Medicine, its statutes dating from 1309. The University began by being established, first in Lisbon, and then moved to Coimbra in 1308. Throughout the fourteenth century, the University's location alternated between the two cities, but in 1537, under the rule of King João III, it was definitively established in Coimbra. Between 1559 and 1759, Coimbra competed with the University of Évora, which was run by the Jesuits (Ramos et al. 1997).

When in 1750, the Marquis of Pombal, King José's Prime Minister, became the strongman of Portugal, a set of reforms was launched in the framework of Portuguese Enlightenment the purpose of which was the modernization of the country in accordance with European canons. Education was one of Pombal's targets. Pursuing a utilitarian political agenda, he created the College of Nobles, in Lisbon, and reformed the University of Coimbra (Braga 1898; Carvalho 1986). Additionally, as part of a wide political strategy of annihilation of his opponents, the Marquis of Pombal expelled the Jesuits from Portugal and closed the University of Évora. In the context of the 1772 reform, the University of Coimbra incorporated the Faculty of Philosophy, which included courses on physics, chemistry and natural history, and the Faculty of Mathematics, both playing, however, essentially the role of preparatory schools.

About half a century later, this very role of preparatory training, preceding the enrolment in Engineering in the Lisbon Army School or in Medicine and Pharmacy at the University of Coimbra, was replicated in the newly created Oporto Polytechnic Academy and the Polytechnic School of Lisbon, founded, respectively, in 1836 and in 1837, in the context of Liberalism (Braga 1902; Carolino 2012).

Until the beginning of the twentieth century, Portugal remained alien to the new European movements, which led to the creation of "research schools or groups" ensuring the continuity of research programmes and working methods. Whether voluntarily or not, research in Portugal was almost always oriented to the immediate utility by the State.

The Portuguese Republic established on 5 October 1910 sought to modify this situation. The Republican programme was structured around the modernization of Portuguese society marked by its rural character, weak industrialization and high rates of illiteracy (Catroga 2000). Education was one of the Republicans' banners and a surge of legislation was initiated with the 1911 reform of higher education (Carvalho 1986; Cunha 1916; Gomes et al. 1988; Matos 2013). The most outstanding figures of Portuguese Republicanism were inspired by Comte's and Littré's Positivism and a triumphalist vision of knowledge, which would culminate in the positive or scientific stage, the cradle of Republicanism.

The newly created faculties of sciences were invested with a symbolic character. They became a reference for all those who advocated the ideal of disinterested scientific research, like the humanities or the letters, not necessarily associated with the solution of immediate problems. As stated in the 1911 legal text, to the universities of both Lisbon and Oporto was ascribed a triple mission (Cunha 1917):

a. The promotion of the progress of science by teachers and the initiation of an elite of students in the methods of scientific discovery;
b. The general teaching of the sciences and their applications, by providing students with the skills required by scientific and technical careers;
c. The promotion of both the methodical study of national problems and the diffusion of high culture through the methods of university extension.[1]

The general programme and the regulations of the faculties of sciences were launched soon after (Simões et al. 2013a).[2] The faculties of science were ascribed with the mission of conferring the academic degrees of Bachelor and PhD in one of three areas corresponding to the sections in which they were organized: mathematics,

[1] Decree dated 9 April 1911 published on 22 April 1911– Bases da Nova Constituição Universitária; Decree dated 12 May 1911– Plano Geral de Estudos nas Faculdades de Sciências.

[2] Decree dated 12 May 1911– Plano Geral de Estudos nas Faculdades de Sciências.

physics and chemistry, and natural history. As it was then common in Europe (Fox and Weisz 1980; Carneiro et al. 2014), the Portuguese faculties of sciences also provided a general education corresponding to a Bachelor's degree, renamed *licence* in 1918,[3] followed by a specialised education in Engineering and Medicine, or in schools of application such as Pharmacy or the Normal School.

In this context, the expression 'faculty of sciences' meant an institution devoted to teaching and research in which the sciences were no longer envisaged as mere propaedeutic to engineering, medicine and pharmacy, but as areas with strategic value worth exploring, at least ideally. The 1911 legislation aimed at forcing the implementation in Portuguese universities of ideas dating back to the foundation of the University of Berlin, in 1810, in particular the Humboldtian notion that knowledge has intrinsic value, independent from its ulterior applications. Consequently, in science faculties, research should have a centrality it never had before, and teaching should be oriented to the initiation of students in the methods and practices of scientific research (Schaffer 1990; Paul 1972). These were the principles advocated by the *Generation of 1911*, who actively engaged in the promotion of laboratory-based research and whose members voiced their opinions in newspapers and journals addressing multiple audiences (Athias 1940; Bensaúde 1922; Costa 1917, 1918).

However, the legislation and the problems discussed in the meetings of the Council of the Faculty of Sciences of Lisbon, composed of a handful of full professors, as well as the rhetoric of some of the ideologues of Portuguese higher education belonging to the *Generation of 1911*, show the inexperience of the actors involved, both about the essence of a faculty of sciences, and the meaning of consistent and organized scientific practices. In effect, passing a law prescribing a new mission and patterns for higher education was much easier than materializing the Republican reform, in as much as Portuguese higher education had never experienced the movements that had transformed the European university scene from the early nineteenth century onwards. Replacing practices and habits of thought, and changing people's minds is a highly complex task, and it was aggravated by the fact that the new schools inherited teachers, students, staff as well as the structural problems that had affected former institutions with essentially different purposes. Moreover, the faculties of sciences had to carve a place of their own among other schools for higher education.

The inheritance left both by Pombal's eighteenth-century utilitarianism and the subsequent technical-professional orientation of the education programme launched by the nineteenth-century Liberals, together with the power of influential professional groups such as those of the engineers and medical doctors, rendered the social acceptance of the faculties of sciences particularly difficult. Their main mission was, on the one hand to impart the spirit of scientific research during the preparatory education preceding a professional specialization, and on the other, to train a fraction of its students, however small, to become professional scientists, in this way themselves becoming ramparts of scientific research.

[3] By the Decrees 4 554 dated 6 July 1918 and 4 647 dated 13 July 1913, the Bachelor is replaced by the licence and doctoral insignia were re-introduced.

The case of the Faculty of Sciences of the University of Lisbon is particularly striking. Despite different objectives, during the first decades of its existence the Faculty of Sciences presented itself as the natural heir of the Polytechnic School of Lisbon, which, during the nineteenth century, had occupied the same buildings close to the heart of the city of Lisbon in what came to be known as the Sciences Hill. The odd insistence on institutional continuity and on the use of a familiar historical past as an authoritative argument reflected first and foremost the fragile institutional context in which the Faculty of Sciences emerged, and also the difficult demarcation of competences among the various institutions for higher education created simultaneously in the First Republic.

Although the dictatorship of the Estado Novo, which followed the 1926 military coup d'état that overthrew the republican regime and established a dictatorial one in 1933, did not change the overall structure of the republican higher education framework, the authoritarian nature of the regime was reflected in both individual and institutional freedom. The autonomy of the academic world became a pressing issue, not only in pure political terms, that is, as a way to oppose the dictactorship, but also in a tense and long discussion on the substance, relevance and form of research, involving both teaching staff and students (Simões et al. 2013a).

16.3 Scientific Research, a "Truly Hazardous Occupation"[4]

The various actions and reactions, suggestions and discussions surrounding the implementation of the new research *ethos* that came to build the identity of the Faculty of Sciences are particularly evident when we look back at the events leading to the expulsion of academics from higher education institutions, including some Faculty members, in 1947.

Following the victory of the allies, the Portuguese dictatorship was forced by the international community to allow the country to live ephemeral moments of openness to the world together with faint gestures towards democracy. The National Assembly was dissolved and elections scheduled for November 1945; a period of ten days was given to the presentation of candidacies, and a month was allowed for the electoral campaign. Soon, the opposition, which up to then had survived clandestinely, organized meetings and coalitions by congregating different political orientations, all petitioning for the extension of the electoral period. From the work-

[4] Flávio Resende wrote, in 1945, a text republished in 1948, in which he mentioned: "In 1937, back from Germany, where I had completed a PhD, I met an old friend in Oporto, who asked me: 'I have heard that you have returned to Portugal with the intention of pursuing scientific research?' As I have answered yes, he thought that as a good friend he should warn me: 'In effect, there are people who do it, but I must tell you that of all occupations here it is the only one which is hazardous'. I laughed and only ten years later I truly understood his words of wisdom and the great friendship of this old companion!" (Resende 1948, p. 3).

ing class to intellectuals, thousands of citizens, including physicists of the Faculty of Sciences of Lisbon, subscribed to this petition (*Seara Nova* 1945).

Their plea, however, was not heard and the social and political atmosphere rapidly deteriorated. In October 1946 and April 1947, various military insurrections and strikes occurred. In June 1947, the dismissal of 21 university professors and teaching assistants was announced on the grounds that they had contributed to the on-going social unrest and political turmoil. The official note read: "it is known that there are university professors and assistants who either ostensibly or covertly encouraged agitation and the agitators. They have shown they were more interested in ideological proselytising than in fulfilling their teaching duties" (*Diário de Lisboa* 1947). The members of the Faculty of Sciences of Lisbon who were expelled included the young physicists Manuel Valadares (Salgueiro and Carvalho 2001), Aurélio Marques da Silva and Armando Gibert, as well as the young full professors, the geologist Carlos Torre de Assunção (Alves 2001), and the botanist Flávio Resende (Catarino 2001; Catarino and Simões 2011).

It is our contention that the 1947 purge was not exclusively a direct consequence of the political positions of those opposing the *Estado Novo* dictatorship, at least in what relates to the Faculty of Sciences of Lisbon; rather, political reasons, although real, provided the government with a much-needed motive to solve once and for all a quite tangible problem dividing members of academia, that of a new *ethos* of scientific research, which involved a complex change of mentalities (Gaspar and Simões 2011; Simões 2011).[5]

The young generation's attitude towards research was shared by a few senior professors such as the physicist Armando Cirilo Soares (Moreira 2001), who defined himself as belonging to an older tradition "prior to the pro-scientific research era" and fought for a change of mentalities.[6] They all advocated the change of the academic *status quo* through the introduction of a new culture according to which scientific research was at the core of the Faculty of Sciences of Lisbon (Resende 1947, 1948; Serra 1957; Simões et al. 2013a, b). The physicist Valadares, Cirilo Soares' main collaborator in the Laboratory of Physics—a research unit moulded by an experimental culture that resulted in a high-quality international reputation—actively and publicly voiced his criticism. Valadares drew attention to the need for a reform of university teaching, and the remodelling and updating of the courses. Moreover, upon their return from abroad, he advocated that former scholarship holders should be provided with the material and institutional conditions to enable them to develop creatively a research career. Valadares' stark criticism of the state of the faculties of sciences was apparent from the title he chose for his opinion article: "The Faculties of Sciences should be reformed because, as they now function, they are merely first class secondary schools" (Valadares 1945).

[5] See Minutes of the Council of the Faculty of Science of Lisbon.

[6] Arquivo Histórico do Museu de Ciências da Universidade de Lisboa (AHMCUL), Lv. 1442, Minutes of the Council of the Faculty of Science of Lisbon, Book nº8, 18 November 1944 to 1952, on p. 13. Session dated 22 December 1944, on p. 66v. Session dated 23 October 1947.

The botanist Flávio Resende was among the young full professors of the Faculty of Sciences who were expelled. He had completed a Ph.D. in Germany, and following his return to Portugal engaged in the change of the university's *status quo* by insisting on the central role of scientific research. A friend had kindly warned him: "of all occupations in this country [research] was the only truly hazardous" (Resende 1948, p. 3). Readmitted soon after the purge, Resende's statement read at the Council of the Lisbon Faculty of Sciences reveals the depth of the ongoing controversy:

> I take this opportunity to inform Your Excellence that I have to conclude from the justice done by the Nation's Government to the allegations of my appeal that *our removal did not result from motives of political order—I have never been a political person in the sense of an allegiance to a political party—but rather from our commitment to defend the complete efficacy of higher education*. From my personal point of view—given the invitations I have been receiving from abroad—I am not rejoicing with my reintegration. *As a Portuguese, however, I congratulate myself when I see that the Government of my country succeeded in dismounting the camouflage woven around the real issue, by implicitly backing up the pursuing of my "policy" which is solely the promotion of true culture.*[7]

The research *ethos* shared by Resende and others was based on the pursuit of original research and not the mere mastering of well-established knowledge. It advocated specialization as opposed to encyclopaedism and memorization; experimental practices as opposed to bookish knowledge; the role of supervisors in guiding their PhD students instead of leaving them to fall prey of a defective self-education; PhD dissertations submitted within reasonable time spans (four years average), counteracting the tradition of the eternal assistant lecturer who for decades merely reproduced his/her seniors' practices; the relevance ascribed to original research in the evaluation of a PhD candidate; the importance of creating suitable material conditions for PhD students, both by decreasing the time spent lecturing and providing the research infrastructure needed to produce a new style of young scholar; the prohibition of PhD students from being in charge of delivering theoretical lectures; the defence that evaluation panels of dissertations and competitions for university positions should not be strictly composed of senior staff members from within the institutions, but should include external experts. In short, a commitment to the progressive professionalization and internationalization of scientific research carried out by university teaching staff, both junior and senior.

The half-century duration of this debate, which propagated throughout the whole University of Lisbon, increasing to the point of becoming "deafening" in the 1960s (Ramos do Ó 2013), shows how the weight of tradition tenaciously opposed change. It was in the context of this debate that the *Journal of the Faculty of Sciences* emerged as an important element in the construction of the Faculty's identity as a *locus* of scientific research.

[7] AHMCUL, Lv. 1442, ibidem, on p. 65v. Session dated 23 October 1947. Telegram sent on 29 September 1947 by Flávio Resende to Pereira Forjaz. Our italics.

16.4 The Journal of the Faculty of Sciences of Lisbon: Responding to the Debate on Scientific Research

In the celebrations for the Centenary of the Lisbon Polytechnic School, the former rector of the University of Lisbon, the mathematician Pedro José da Cunha (Carolino 2011; Saraiva 2002), by aligning himself with the role and *praxis* of scientific research, identified the place of the Faculty of Sciences as a true "research centre" (Cunha 1937, p. 84). The coincidence of the date of Cunha's claims with the date of publication of the first issue of the *Journal of the Faculty of Sciences*, both in 1937, was not accidental, and materialized the will to put scientific research on the agenda. However, the creation of the *Journal* reflects a mix of internal and external factors, intertwined with the new approach to research.

From 1921 onwards, and for more than a decade, the Rectorate had been receiving requests from foreign universities, libraries and other institutions interested in the scientific production of the University of Lisbon. They requested publications written in widely spoken languages, such as English or French, and proposed to exchange them with their own scientific publications.

The acquisition of books and journals, the exchange of journals with foreign institutions, the circulation of books among students, turned the Faculty's library into a core unit in the development of both teaching and research. Whatever the strategies for the creation and promotion of a new laboratory-based scientific culture, they could not bypass the need to update and master current bibliography in all scientific areas of the Faculty. Therefore, it is not coincidental that the *Journal* emerged in close association with the library and funded initially by its budget. Its importance is clear not only from the number of copies, initially amounting to 1000, but also from the regular funding awarded by the federal Institute for High Culture, and finally from its widespread distribution around the globe, which in the 1960s numbered more than 200 countries and 5500 institutions (see Fig. 16.1).[8]

In addition, the publication of the *Journal* was part of the expansion of the publishing movement launched in the 1920s and 30s, which encompassed journals associated with learned societies, often devoted to the popularization of science, and journals and magazines published by students' associations and the faculties. Despite the specialized journals published by the different units of the Faculty of Sciences, the need to create a journal capable of overcoming the usual disciplinary barriers was deemed highly important. This ploy acted not only as a fundamentally cohesive element within Faculty walls, but also heralded both nationally and internationally the research carried out at the Faculty of Sciences of Lisbon.

Between 1937 and 1950, the *Journal* published 37 articles, most written in Portuguese and authored by male Faculty staff members, both senior and junior. Contrary to what occurred in the second stage, there were no contributions from outside the Faculty or from women.

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[8] AHMCUL. Letters sent 1950–1955. Cx 2449. See Publicações que Permutam com a Revista da Faculdade de Ciências da Universidade de Lisboa (List of publications exchanged with the Journal of the Faculty of Sciences). Lisbon, 1961.

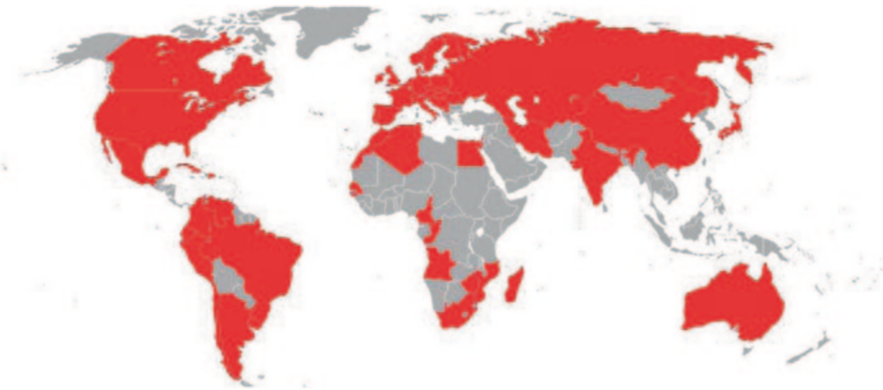

Fig. 16.1 Map representing the countries (in *red*) receiving the *Journal* in 1961

Three different kinds of articles were published—historical papers, obituaries, and scientific contributions, including dissertations. Articles then fulfilled two distinct functions:[9] obituaries of professors, and articles of a historical bent aimed at consolidating the Faculty's identity as the 'natural successor' of the former Lisbon Polytechnic School. Scientific articles, in turn, by covering a variety of scientific fields—the vast majority on physics but also on botany, mathematics, astronomy, geographic engineering, positional astronomy, geophysics and biochemistry—reinforced the innovative dimension of the Faculty of Sciences as a research establishment.

In this first stage, halfway between two different worlds, the *Journal* showed a hybrid character between a journal of institutional memory and one trying to find its place among scientific publications. The latter orientation had its main representative in the scientific output of the experimental research school led by Cirilo Soares, in the Laboratory of Physics, and in the contribution of the German chemist Kurt Jacobsohn, professor of the Laboratory of Chemistry of the Faculty of Sciences and leader of a research school of biochemistry located at the private Institute Bento da Rocha Cabral. Both show the relevance these two research schools had in the definition of the new research ethos within the Faculty of Sciences (Geison 1981; Geison and Holmes 1993).

From 1946 to 1950, the *Journal* substantially reduced its rate of publication and the variety of its contents. This fact is not certainly alien to the above-mentioned purge, which affected leading scientific figures of the Faculty, causing the dismantling of the Laboratory of Physics.

In the academic year 1950–1951, the *Journal* presented a new profile both from the editorial point of view and content wise. It was divided into three independent series, which coincided with the internal organization of the Faculty: Mathematics, Physics-Chemistry, and Natural Sciences. This division, which followed

[9] The typological classification of the articles: 8 of historical character; 7 obituaries; 11 scientific articles; 8 review articles; 3 dissertations.

the political turmoil of the late 1940s, reflected not only the evolution towards the consolidation of research practices and a growing specialization within the Faculty of Sciences, but also the weight of external demand resulting from an effective international exchange system. Despite the *Journal's* unity regarding the role of scientific research, there are marked differences in the way the tripartite series understood and expressed their views on how to consolidate scientific research in the Faculty. Their options regarding editorial style, working language, and the weight given to the contribution of foreign authors were different, reflecting distinct traditions and the internationalization agenda.

The purposes of the rejuvenated *Journal* were clearly expounded in a letter dated 30 May 1951 from the Dean sent through the Rector to the Chancellor of the Exchequer, to whom he requested exceptional financial aid in order to secure the remodelling of the *Journal* so as to turn it into a "collection of pieces of scientific research carried out by both professors and their assistants, in order to honour the country abroad and attract specialized publications in exchange, which are indispensable and too expensive to buy."[10]

The increasingly scientific character of the *Journal* in this second stage was also expressed by the explicit assumption of an editorial committee composed of one person per area, all deeply involved in scientific research (Amaral 2011; Ribeiro 2001). The three series lasted until the late 1960s and the beginning of the 1970s.[11] Their disappearance is certainly associated with a variety of reasons, ranging from the political openness felt during the agonizing period of the dictatorship, from which the scientific community took advantage in order to accelerate its own internal scientific dynamics, to the return to Portugal of a new wave of scholarship holders trained abroad insisting on publishing in international specialized journals. Later, the establishment of the democratic regime also contributed to the silent disappearance of the *Journal* by driving away from academic research life many members of the teaching staff who privileged political, social and cultural activities during the first years of democratic euphoria, following the so-called Carnation Revolution of 25 April 1974 which overthrew the dictatorship.

16.4.1 The Mathematics Series: Going International

The first director of the Mathematics series of the *Journal* was Vicente Gonçalves, the renowned mathematician and professor at the Faculty of Sciences, since 1942 (Oliveira 2001). From 1947 to 1951, he held simultaneously the post of Head Librarian Professor and was deeply engaged in the dissemination of the *Journal*

[10] AHMCUL. Publicações nº 1. Cx 1654. Letter to the Dean of the Faculty of Sciences to the Rector, dated 30 May 1951, requesting the letter to be sent to the Chancellor of the Exchequer. The rejuvenated Journal was also the first topic addressed by the Dean in his 1950–1951 annual report. See Anuário 1950–1951, 1951).

[11] The first series, physics and chemistry, ended in the 1967–1968 academic year, followed by mathematics in 1972–1973, and the natural sciences in 1973–1974.

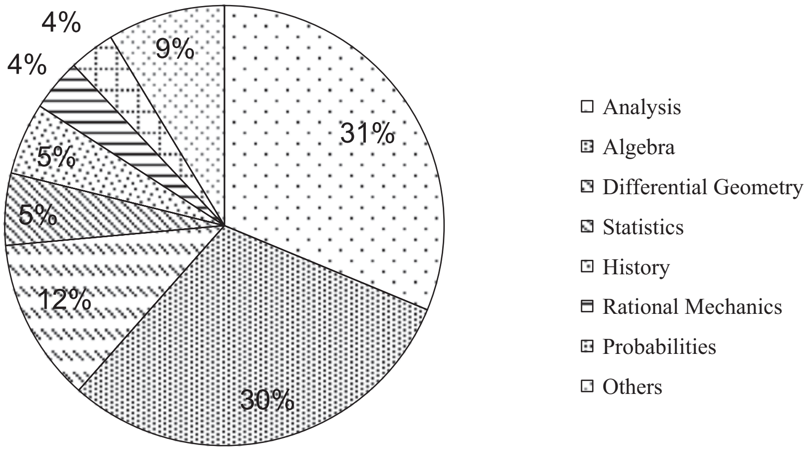

Fig. 16.2 Distribution of papers by mathematical areas in *Revista, 2ª Série A –Ciências Matemáticas*

through the exchange of periodicals among libraries around the world, then common practice. Disagreements over the aims of the series account for the frequent and often tumultuous, change of directorship, and the delays in the publication of successive issues.[12]

Discipline coverage was very asymmetrical. Analysis (33 %) and algebra (32 %) held a hegemonic status, followed by differential geometry (13 %), and *ex-aequo* by statistics and history of mathematics (6 %). The relevance of history of mathematics resulted from a series of ten articles authored by Vicente Gonçalves in "Historiae ac Pedagogiae de Minutiis", which appeared over 10 years of publication (vols.1–8). As clear from the title, for Vicente Gonçalves, history of mathematics was the handmaiden of pedagogy, and the means for the discussion of concepts and authors of various historical periods(see Fig. 16.2).

The fact that analysis and algebra covered jointly 65 % of all papers points to the sheer importance of pure mathematics for professors of mathematics in the Faculty of Sciences. The will to present mathematics as an "autonomous science" and not merely a "subsidiary and auxiliary" one (Dionísio 1987), as happened in the days of the former Polytechnic School of Lisbon, was a central issue in the strategy for the affirmation of the discipline, and often was part and parcel of the rhetorical devices used to support it.

Although less represented than analysis and algebra, statistics also played an important role especially due to the commitment of Tiago de Oliveira (Leal 2001), who began working at the Institute of Marine Biology in the early 1950s. His

[12] AHMCUL, Lv. 1444, Minutes of the Council of the Faculty of Science of Lisbon, Book nº10, 20 February 1963 to 19 October 1966, on p. 197. Session 19 October 1966. AHMCUL, Lv. 1445, Minutes of the Council of the Faculty of Science of Lisbon, Book nº11, 23 November 1966 to 24 February 1971, on p. 4. Session 16 December 1966; on p. 18v. Session 25 October 1967.

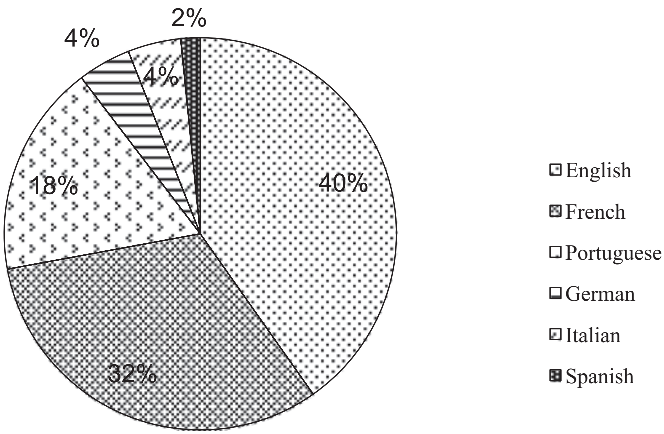

Fig. 16.3 Distribution by language of the papers published in *Revista, 2ª Série A –Ciências Matemáticas*

preference for applied mathematics, in particular statistics and probability, points to his future plea for the institutional separation of pure and applied mathematics (Oliveira 1987).

The drive towards internationalization is a very clear trend in the series of mathematics. Of all 251 papers published during its 24 years of existence, 101 were written in English, 80 in French, 11 in Italian, 11 in German, and 4 in Spanish. Just 44 papers were written in Portuguese. The majority fraction of papers written in a foreign language (around 82.5 %), in English (49 %) and French (39 %), show the will of national authors to be known by their foreign peers. All Portuguese authors wrote both in Portuguese and in another foreign language, their choice often being the result of individual networking preferences. The 101 papers written in English include 37 papers by Indian authors, five by Americans, four by Japanese, one by an Israeli, one by an Australian, and another by a Iraqi; the 80 papers written in French include seven by French authors; the 11 written in German include one by a German native speaker; and the four papers written in Spanish were authored by Spanish or South American scientists(see Fig. 16.3).

Despite the participation of foreign scholars, Portuguese mathematicians were the authors of around 73 % papers, and among them a core group of people secured a steady participation throughout the decades of the series' existence. They were respected academics directly involved in the editorial policy of the *Journal* and especially eager to disseminate research carried out in the Faculty of Sciences. Irrespective of the many outlets, often foreign, chosen for their publications, they opted intentionally to publish in foreign languages in the *Journal*, instead of publishing exclusively in journals abroad. Their choice shows their aim of going international, using the *Journal* as the privileged mediator between them and their foreign colleagues.

Of all authors, the tutelary figure is undoubtedly Mira Fernandes. He was a professor at the Technical Institute, the higher education school of engineering established in the capital in the same year as the Faculty of Sciences but outside the University of Lisbon. Despite publishing in the Institute's journal *Technics*, Mira Fernandes' presence in the *Journal* was a token of his status as the reference figure for Portuguese mathematics; volume 4 (1954–1955) was entirely dedicated to him. In 1943, together with the mathematicians Aniceto Monteiro and Ruy Luís Gomes (both exiled in Latin America due to disagreements with the dictatorial regime), he founded the Mathematical Research Board. Together with the creation of the journal *Mathematical Gazette* and the Portuguese Society of Mathematics, these forums were at the core of the activities of the so-called *Generation of 1940*, which aimed at implementing mathematical research in Portugal as an autonomous activity independent of the applications to other scientific and technical areas (Bragança Gil 2003; Monteiro 1942; Perez 1997).

An admirer of Mira Fernandes, Vicente Gonçalves was a strong presence in the *Journal*, and was considered by his peers as the mathematician responsible for "the introduction of modern criteria of rigor in the teaching of mathematics in Portugal."[13] Although one cannot speak of a research school headed by Vicente Gonçalves, like Mira Fernandes before him, he acted as the reference for the next generation of mathematicians, who often felt they were his disciples, even if only on an informal basis.

As to algebra, contributors to the *Journal* included the founder of the so-called 'Algebra school of Lisbon' Almeida Costa, José Dionísio, and the statistician Tiago de Oliveira.

In 1953, three years after the beginning of the series, the first paper authored by a woman appeared. On the whole, five women wrote for the series, contributing 12 articles.

The presence of foreign authors is prominent in the area of differential geometry and is dominated by Indian mathematicians working at the University of Lucknow, a prestigious institution heir to the famous Canning College, or at the Technological Institute Indore. The other regular connection is with the United States of America (USA), specifically with the University of Illinois, and reflects the interaction of Vicente Gonçalves with his student Evelyn Frank, who dedicated an article to him in the *Journal*.

The agenda of internationalization is also visible in the frequent stays abroad supported by grants from the Portuguese Institute for High Culture, the private Calouste Gulbenkian Foundation and the international organization NATO. Often acknowledged in the articles, financial support was also discussed in the Council of the Faculty of Sciences, which furthermore advertised grants and protocols in order to facilitate the travels and stays abroad of staff members.

[13] AHMCUL, Lv. 1444, Minutes of the Council of the Faculty of Science of Lisbon, Book nº10, 20 February 1963 to 19 October 1966, on p. 104. Session 12 January 1965.

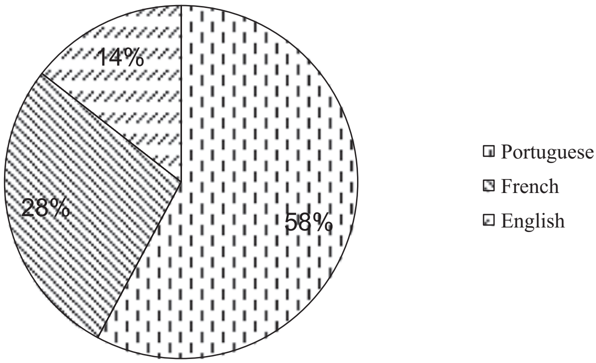

Fig. 16.4 Distribution of languages by articles in the *Revista, 2ª Série B –Ciências Físico-Químicas*

In the national realm, the Mathematics Seminar of the Faculty of Sciences, since 1953, and the Centre for Mathematics applied to the Study of Nuclear Energy, since 1955, became the institutional haven for mathematical research to such an extent that publications often acknowledged their role.

16.4.2 The Physics and Chemistry Series: The Appeal of Biochemistry, of Nuclear Energy and of the Atmosphere

The physics and chemistry series was the shortest-lived of all series publishing few, but comparatively longer, articles. Articles of an historical bent, obituaries, reviews or bibliographic references were absent from this series, which assumed a strictly scientific build-up from the start. By including mostly articles published by members of the academic staff of the Faculty of Sciences (70 % of all papers), this series mirrored the research carried out within the Faculty's walls. The remaining articles were written either by foreign scholars (13 %) or by national authors (18 %) belonging to institutions other than the Faculty.

Having this characterization in mind, it is understandable that of the 83 articles published in this series, six were doctoral dissertations submitted by teaching assistants to the University of Lisbon or to foreign universities. The predominance of papers written in Portuguese (58 %) counteracts the agenda of internationalization behind the implementation of a new research *ethos*. Of all foreign languages used, French (28 %) and English (13 %) dominated(see Fig. 16.4).

Publications in the series are divided among three main areas: chemistry (53 %), physics (29 %), and biochemistry (18 %). When contrasted with the initial stage of the *Journal*, before it split into three series, these percentages show a marked reorientation in research areas, especially in chemistry (from 0 to 53 %) and biochemistry (from 3 to 18 %), physics maintaining roughly the same percentage (from 30 to 29 %)(see Fig. 16.5).

The stable percentage of contributions on physics might seem quite unexpected at first sight. In fact, in the initial stage most articles in the series were authored by

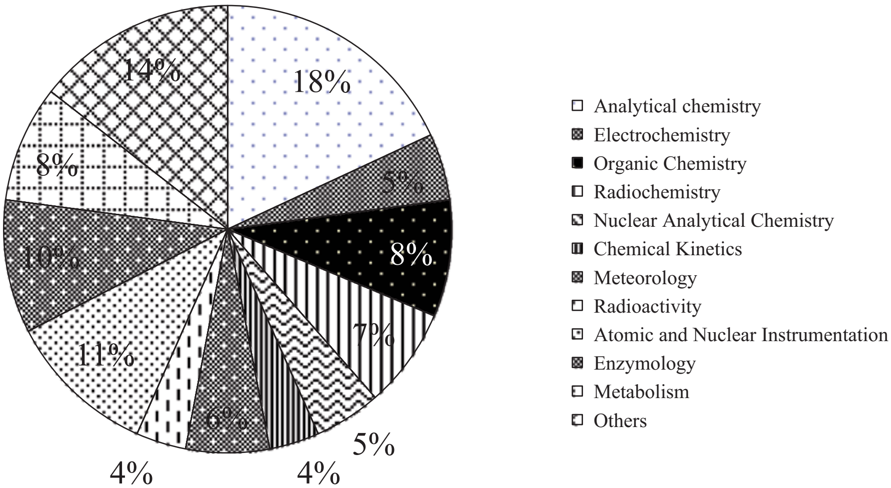

Fig. 16.5 Distribution by scientific areas of papers published in *Revista, 2ª Série B –Ciências Físico-Químicas*

members of the Laboratory of Physics (Gaspar 2009; Gaspar and Simões 2011), some of whom had been expelled in the meantime from the university system, following the dramatic events of 1947, to which Cirilo Soares, the Laboratory director, responded by resigning from his position in solidarity with his collaborators. While the dismantling of this research group could have been responsible for a considerable decrease in its publication output, the fact of the matter is that the majority of publications continued to stem from members belonging to the Centre of Studies on Physics, existing since 1942 and located at the Laboratory of Physics. Under the leadership of Lídia Salgueiro, a former female student of Valadares, research on experimental atomic physics continued. This was supported by regular exchange of scientific correspondence with Valadares, then exiled in France and working as *attaché de recherches* at the CNRS in Paris, and despite the close surveillance by the Portuguese political police who was aware of the communist inclinations of Valadares and of his French connections.

The Laboratory of Physics also housed physicists and chemists associated with another research centre, the Centre of Studies on Nuclear Physics, created in 1952, located at the Portuguese Institute of Oncology. Contrary to most State-funded research centres, this one was not located in the university premises because of the interest shown by the dictatorship, right after the end of the Second World War, in funding physical applied research on nuclear energy, including cancer treatment and alternative forms of electric energy production. The communist connotations of former members of the Laboratory of Physics had to be silenced, and the Spanish physicist Julio Palacios was hired as invited professor and head of both centres of Studies on Physics and on Nuclear Energy.

Palacios was a full professor at the University of Madrid, who had been vice-rector, and was also a researcher at the *Research Physics Laboratory* in Madrid. He had entertained for some time collaborations with the Portuguese scientific community, and specifically with the Laboratory of Physics in Lisbon (Laranjeira 1992; Sanchez-Ron 2002; Mañes 2008). On good terms with the dictatorial regimes of both Spain and Portugal, Palacios was hired with the consent of the members of the Council of the Faculty of Sciences, some of whom, despite having preferred to force the readmission of those formerly expelled,[14] acknowledged his unequivocal qualities as a scientific researcher.

As head of both centres, Palacios was able to supervise research in areas such as electrochemistry, radiochemistry, and nuclear instrumentation, often geared towards applications to medicine and cancer treatment. To a large extent, he was responsible for a substantial fraction of publications on chemistry in the *Journal*. His practice shows how areas including radioactivity, radioisotopes and nuclear studies, in the borderline between physics and chemistry, became progressively sites of interdisciplinary research, in time extending to other disciplines such as geology and mineralogy, botany, zoology and statistics.

Finally, publications also reveal a parallel strategy of consolidation of geophysics, notably through the creation of an undergraduate degree, the consolidation of research at the National Meteorological Service, and the award of scholarships to enable young researchers to study abroad. José Pinto Peixoto stands out as the first to be awarded a PhD degree in geophysics by the University of Lisbon (Miranda and Victor 2001). His publications were often the result of projects taking place at the Massachusetts Institute of Technology under the supervision of the atmosphere physicist V. P. Starr, and signal the transition towards theoretical meteorology, in which mathematical simulation, supported by numerical analysis, became the basis for innovative studies on the dynamics of atmospheric circulation.

Having in mind the main areas of physics, it becomes easy to understand the distribution of publications on chemistry. The traditional areas of organic and analytical chemistry, often applied to biology, geology, or nuclear matters, dominated the scene. In the latter case, papers on chemistry of radiations, radiochemistry and nuclear analytical chemistry were essentially connected with two research groups: the one located at the Laboratory of Radiochemistry, which was associated with the Centre of Studies on Radiochemistry of the Commission of Studies on Nuclear Energy, directed, after 1953, by Branca Edmée Marques (Ferreira 2001), a former PhD student of Marie Curie, with whom various women worked, two of which authored papers in the series; the other was the Centre of Studies on Physics of the Commission of Studies on Nuclear Energy, directed by Palacios, and included members of both the Laboratory of Physics and the Laboratory of Chemistry.

Articles on biochemistry, especially enzymology and metabolism (18 %), were associated with the research school of biochemistry located at the Institute Bento da Rocha Cabral, led by Kurt Jacobsohn, who taught organic chemistry at the Faculty of Sciences. In this way the Faculty of Sciences of Lisbon became the recruiting

[14] AHMCUL, Lv. 1442, Minutes of the Council of the Faculty of Science of Lisbon, Book nº8, 18 November 1944 to 1952, on p. 67. Session 23 October 1947.

camp for the disciples of Jacobsohn. The research output of both leader and collaborators was published not only in foreign journals, but also in the *Journal*, usually written in German or French (Amaral 2006a, b). When the leading centres of research on enzymology moved from Germany to Great Britain and USA, following the world conflict, this shift caused stringent limitations to the participation of Jacobsohn's group in international debates.

The participation of women in the series, as authors or co-authors, amounts to 13 % and is mainly associated with the groups of Branca Edmée Marques and Jacobsohn.

Research on X-rays and radioactivity, first, and nuclear energy, later, became cohesive elements in cross-disciplinary programmes pushed forward both in mainland Portugal and its African colonies. They were viewed as promising spaces to be explored scientifically, this orientation becoming one of the most striking characteristics of this series.

Under the tutelage of the various Centres of Studies of the Commission of Studies on Nuclear Energy, which finally effected the connection between State and universities, and the Board of Nuclear Energy (1954), the dictatorial regime reacted in its own *sui generis*, often ambiguous, way to the various movements around pacific uses of nuclear energy, in particular applications to medicine and cancer that blossomed everywhere during the Cold War. In this area, the University of Lisbon collaborated with the Portuguese government in the organization of the First Course of Academic Extension, which took place in 1961, and covered various aspects of nuclear energy from basic problems to medical and pharmaceutical applications, and the implications of nuclear matters in the domain of law and culture.

16.4.3 The Natural Sciences Series: Fundamental Science and Interdisciplinarity

The series on natural sciences began to be published in 1950, with the geologist Carlos Teixeira being its representative on the editorial committee. Of all authors contributing to this series, 30 % were members of the Faculty of Sciences, 32 % were foreigners and 38 % were Portuguese working in other institutions. The high percentage of contributions associated with institutions other than the Faculty of Sciences shows the role of the series as a mediator between the Faculty and the outside world. Papers were written in Portuguese (62 %), French (24 %) and English (12 %), and the remaining in Spanish or German(see Fig. 16.6).

During its existence, the series was organized in three relatively stable sections: first mineralogy, geology and palaeontology; second botany; and finally zoology and anthropology. This thematic division mirrors the internal organization of the research spaces inherited by the Faculty of Sciences from the nineteenth-century Polytechnic School, such as the National Museum of Natural History, or more recent ones like the laboratories, which shows their increasing importance in biological practice. Such was the case of the Zoological and Anthropological Museum and Laboratory and the Botanical Institute (Kohler 2002).

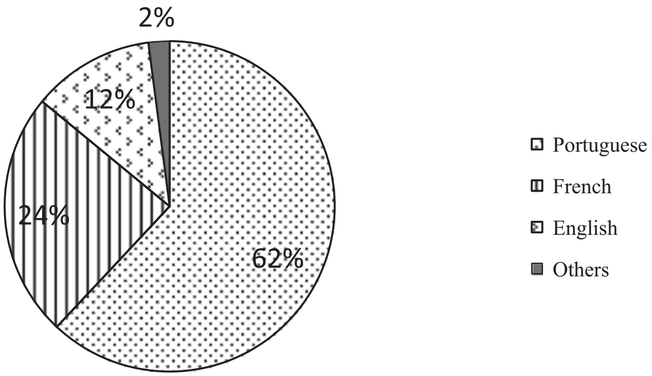

Fig. 16.6 Distribution by language of the papers in *Revista, 2ª Série C –Ciências Naturais*

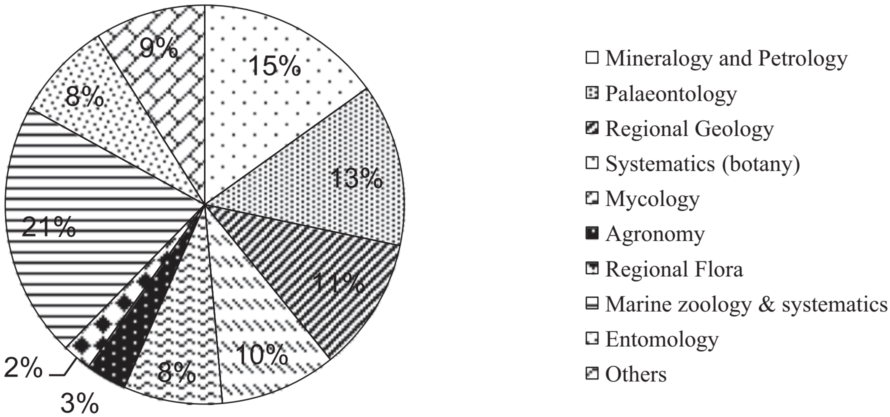

Fig. 16.7 Distribution of papers by scientific areas *2ª Série C—Ciências Naturais*

Of a total of 240 papers published between 1950 and 1974, around 40 % addressed geological issues, 33 % zoology and anthropology, and 27 % botany, including their various sub-disciplines(see Fig. 16.7).

Not all faculty members published regularly in the *Journal*, nor do articles denote compellingly scientific notoriety on the part of their authors. For instance, those of Flávio Resende and José Antunes Serra, both working in the emerging area of genetics, are paradigmatic examples of alternative choices. They both preferred to publish in prestigious international journals such as *Nature*, *The Nucleus*, *Science* and *Plantae*, and to engage themselves in creating and sustaining a specialized journal, *Portugalia Acta Biologica.*[15] Notwithstanding these exceptions, the *Journal* is a reliable indicator of research in different scientific areas.

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[15] We thank the botanist Fernando Catarino, who was a student of Flávio Resende and a member of the group, for this information.

Regarding geology, from 87 articles, mineralogy and petrology represent 37% of the articles, followed by palaeontology (29%), in both areas cabinet work prevailing over fieldwork, and finally regional geology (26%). It is worth noting that in Portugal the practice of fieldwork, as well as of stratigraphy, both intrinsic to geological practice, only started in the second half of the nineteenth century, in the context of the Portuguese Geological Survey, a department of the Ministry of Public Works, Trade and Industry. The Lisbon Polytechnic School had remained attached to cabinet work (Carneiro 2005; Leitão 2003). Only in the mid-twentieth century was Carlos Teixeira able to introduce fieldwork and geological surveying in research practices at the Faculty of Sciences.

The connection with the so-called "geological school of Porto", headed by Carrington da Costa, director of the Centre of Mineralogy and Geology of the Commission of Studies on Nuclear Energy, the Institute for High Culture and the Executive Commission of the Colonial Research Board, explains the collaborations between geologists of the Faculty of Sciences and elements of other institutions, as well as the inclusion in the *Journal* of topics on nuclear energy or themes related to the African colonies (Mota 2007). In the first case, articles on uranium possibly arose from the State's interest and support of research on nuclear energy, which materialized in the creation of the Board of Nuclear Energy, in 1954. In the second case, collaborations with geologists working in Angola, following the establishment of higher education, research institutes and geological services in the Portuguese colonies of Angola and Mozambique, possibly account for scientific articles on African topics, including but not limited to geology.

Finally, the scarce attention paid to tectonics and seismology, which were dormant topics until the 1970s and 1980s, shows that research on historic geology prevailed over investigations on the causes of geological phenomena.

Of all 87 papers on geology, around 30% were written in foreign languages, especially in French, and just a few were published in English; 37% were authored by Portuguese, 27% by foreigners and 30% were co-authored by Portuguese and foreigners. Only five women, two of French nationality, authored or co-authored a total of nine articles.

From 73 papers on zoology, marine biology (60%), and especially cephalopods and sardines (marine seafood), followed by entomology (23%), were the main topics. They had an immediate economic interest, sardines always having played a central role in Portuguese fisheries and the canning industry, and entomology being associated with agriculture/cotton plantations promoted by the dictatorship in the African colonies, especially after the creation of the Colonial Research Board (1936) and the Cotton Research Centre of Lourenço Marques, now Maputo, in Mozambique.

In zoology, as in geology, from the 35 papers written in foreign languages, French took the lead (69%). They were often authored by Portuguese, followed by foreigners or by joint ventures involving Portuguese and foreigners. Of the 31% of articles published in English, three were written by foreigners.

Associated with zoology, physical anthropology was also represented following the nineteenth-century century tradition of studies on the position of Man in evolution. Three papers were published, addressing the anatomical specificities associated with race and gender, two in the 1950s, one being authored by a female author, published in 1968. Five women, one being a foreigner, also contributed articles on zoology amounting to 15 papers, of which seven were co-authored with male scientists.

Finally, of a total of 58 papers on botany, systematics was the prominent area of choice (34 %), followed by mycology (29 %), agronomy (12 %), and regional flora (9 %). Areas such as physiology, metabolism and vegetal ecology were clearly underrepresented, with the striking absence of genetics and biochemistry (as seen already, papers on this latter topic appeared in the series on physics and chemistry). These asymmetries were probably due to the publication options of the staff members of the Faculty who, by being specialists in these areas, chose to publish in reputed foreign journals.

Until the 1970s, Carlos Tavares, who published on mycology, was the most prolific author. Of all those who published occasionally in the *Journal,* some were from USA, Austria, Germany and France, corresponding to countries or institutions with which the *Journal* was exchanged or with whom Portuguese professors entertained special relationships.

Of all 58 articles published, 37 % were in foreign languages: 13 % were written in French, half authored by foreigners and the remaining authored by Portuguese, on their own or in co-authorship with foreigners; 46 % were written in English, half of which by Portuguese. The remaining 41 % were written in German or Spanish.

Regarding women authorship, 10 women authored 18 articles on botany (13 individually). Of all, three were foreigners working in India, USA and Portugal. Scientific couples, both of them teaching at the Faculty of Sciences in the same discipline or different areas of expertise, also co-authored papers in the *Journal*.

The *Journal* mirrors the scarcity of interdisciplinary research in the Faculty of Sciences. This series, however, published five articles with an interdisciplinary character: three on uranium, congregating mineralogists and physicists; one focussed on X-ray applications to the natural sciences; another on X-ray diffraction; and finally one on the application of statistical methods to marine biology.

In the context of the *Journal*, part of the research carried out on the natural sciences was supported by grants from outside institutions such as the Institute for High Culture, the Calouste Gulbenkian Foundation or NATO. Otherwise, researchers at the Faculty of Sciences were associated with its institutes, laboratories and museums, laboratories related to the African colonies or partnerships established with foreign institutions.

16.5 Final Considerations

The *Journal of the Faculty of Sciences of Lisbon* was an important element in the consolidation of a scientific culture in this institution. Throughout its life, the *Journal* showed a hybrid character. Although meant to contribute to the construction of the Faculty's identity as a research *locus* within the spirit of the 1911 Republican reform of higher education, it included initially the publication of institutional memories and obituary notices, which reinforced the idea of the Faculty of Sciences as the natural heir of the Lisbon Polytechnic School. After 1950, already during the dictatorship, its characteristics became those of a mix of scientific journal and a forum for the publication of review papers and dissertations. It addressed both a national and an international readership, as a means to make them become aware of the scientific research carried out at the Faculty of Sciences of the University of Lisbon.

The *Journal* was a crucial player, both symbolically and literally, in the strategy deployed to implement a scientific research culture. By means of articles written in various foreign languages (French, English, Italian, German, and Spanish) authored mainly, but not exclusively, by members of the academic staff of the Faculty of Sciences, the *Journal* became a node in a network uniting the Faculty of Sciences to the world at large. Articles were of different typologies, which varied with time, and included scientific papers, dissertations, monographs and review articles. After 1950, factors such as external pressure, the increase in the volume of publications, and the road towards specialization accounted for the division of the journal into three series, respectively, the mathematics, the physics and chemistry, and the natural sciences, each envisaging research and its internationalisation in different ways.

Mimicking the organizational structure of the Faculty of Sciences, this division shows how interdisciplinary research was still scarce and relegated to a few groups involving members of various research areas, often clustered around nuclear energy and topics of interest to Portuguese colonial policies.

Although not all professors actively involved in changing the Faculty's *status quo* published in the *Journal*, those who did so, used it not as a substitute of publishing in foreign journals, but as a parallel outlet for publication within a 'spirit of mission' geared towards the implementation of the idea of university as a *locus* of scientific research, still to be consolidated in Portugal.

The disappearance of the *Journal* in the early 1970s, right before the overthrow of the dictatorship, which had ruled Portugal for nearly half a century, is still to be explained in detail, but was certainly the result of the deep transformation of the Portuguese university in the atmosphere of freedom that characterized the days following the 1974 Carnation revolution.

References

Alves, Carlos Matos. 2001. Torre de Assunção (1901–1987). Um enciclopedista do século XX. In Memórias de professores cientistas, ed. A. Simões, 58–65. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Amaral, Isabel. 2006a. The emergence of new scientific disciplines in Portuguese medicine: Marck Athias's histophysiology research school, Lisbon (1897–1946). *Annals of Science* 63:85–110.

Amaral, Isabel. 2006b. *A emergência da bioquímica em Portugal: as escolas de investigação de Marck Athias e de Kurt Jacobsohn*. Lisboa: Fundação Calouste Gulbenkian.

Amaral, Isabel. 2011. Kurt Paul Jacobsohn (1904–1991). Uma vida ao serviço da química e da bioquímica em Portugal. In *Novas memórias de professores cientistas,* ed. A. Simões, 31–37. Lisboa: Faculdade de Ciências da Universidade de Lisboa

Anuário da Universidade de Lisboa. 1951. Ano escolar de 1950–51. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Athias, Marck. 1940. *Introdução ao método experimental e as suas principais aplicações às ciências biomédicas e biológicas em Portugal. Congresso do Mundo Português*, Vol. 12, 465–492. Lisboa: Comissão Executiva dos Centenários.

Bensaúde, Alfredo. 1922. *Notas histórico-pedagógicas sobre o Instituto Superior Técnico*. Lisboa: Imprensa Nacional.

Braga, Teófilo. 1898. História da Universidade de Coimbra nas suas relações com a instrucção pública portuguesa. Vol. 3, 1700–1800. Lisboa: Academia Real das Ciências.

Braga, Teófilo. 1902. História da Universidade de Coimbra nas suas relações com a instrucção pública portuguesa, Vol. 4, 1801–1872. Lisboa: Academia Real das Ciências.

Bragança Gil, Fernando. 2003. Núcleo de Matemática, Física e Química: uma contribuição efémera para o movimento científico português. *Boletim da Sociedade Portuguesa de Matemática* 49:77–92.

Carneiro, Ana. 2005. Outside government science, 'Not a single tiny bone to sheer us up!' The Geological Survey of Portugal (1857–1908), the involvement of common men, and the reaction of civil society to geological research. *Annals of Science* 62:141–204.

Carneiro, Ana, Ana Simões, Maria Paula Diogo, and Luís Miguel Carolino. 2014. De l'Ecole Polytechnique de Lisbonne Ã la Faculté des Sciences: enjeux d'identité. In *Les Universités au risque de l'histoire. Principes, configurations et modèles,* ed. Yamina Bettahar, Françoise Birck, and Marie-Jeanne Mailfert, 343–367. Nancy: Les Presses de l'Université de Lorraine.

Carolino, Luís Miguel. 2011. Pedro José da Cunha. Ciência, educação e cidadania na I República. In *Novas memórias de professores cientistas,* ed. A. Simões, 15–21. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Carolino, Luís Miguel. 2012. The making of an academic tradition: The foundation of the Lisbon Polytechnic School and the development of higher technical education in Portugal (1779–1837). *Paedagogica Historica* 48 (3): 391–410.

Carvalho, Rómulo de. 1986. *História do ensino em Portugal desde a fundação da nacionalidade até ao fim do regime de Salazar-Caetano*. Lisboa: Fundação Calouste Gulbenkian.

Catarino, Fernando. 2001. Flávio Ferreira Pinto Resende (1907–1967). Desorganizado, mas mestre. In *Memórias de professores cientistas,* ed. A. Simões, 78–89. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Catarino, Fernando, and Ana Simões. 2011. Flávio Resende (1907–1967). *Letras Comvida* 3: 55–57.

Catroga, Fernando. 2000. O republicanismo em Portugal. Da formação ao 5 de Outubro de 1910. Lisboa: Editorial Notícias.

Comemoração do 1º centenário da Escola Politécnica de Lisboa. 1937. *Revista da Faculdade de Ciências* 1 (1).

Costa, Augusto Celestino da. 1917. Ensino médico e universidades. *Medicina Contemporânea* 17: 1.29; 19:1–29.

Costa, Augusto Celestino da. 1918. *A universidade portuguesa e os problemas da sua reforma*. Porto: Renascença Portuguesa.

Cunha, Pedro José da. 1916. O problema educativo nacional. Considerações gerais. *Revista de Educação Geral e Técnica* (supplement).

Cunha, Pedro José da. 1917. A Universidade de Lisboa e a sua missão social. *Revista de Educação Geral e Técnica* (supplement).

Cunha, Pedro José da. 1937. *A Escola Politécnica de Lisboa. Breve notícia histórica*. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Dionísio, J.J. 1987. Aspectos do ensino da matemática na Escola Politécnica, Faculdade de Ciências. In *Faculdade de Ciências da Universidade de Lisboa: passado/presente, perspectivas futuras. 150º aniversário da Escola Politécnica/75º aniversário da Faculdade de Ciências,* ed.

Fernando Bragança Gil and Maria da Graça Canelhas, 33–39. Lisboa: Faculdade de Ciências da Universidade de Lisboa.
Ferreira, Maria Alzira Almoster. 2001. Branca Edmée Marques (1899–1986). Uma pioneira da ciência. In *Memórias de professores cientistas,* ed. A. Simões, 50–58. Lisboa: Faculdade de Ciências da Universidade de Lisboa.
Fox, Robert, and Georg Weisz, eds. 1980. *The organization of science and technology in France, 1808–1914*. Cambridge: Cambridge University Press.
Gaspar, Júlia. 2009. *A investigação no Laboratório de Física da Universidade de Lisboa 1929–1947*. Braga: Centro Interuniversitário de História das Ciências e da Tecnologia.
Gaspar, Júlia, and Ana Simões. 2011. Physics on the periphery: a research school at the University of Lisbon under Salazar's dictatorship (1929–1947). *Historical Studies in the Natural Sciences* 41 (3): 303–43.
Geison, Gerald L. 1981. Scientific change, emerging specialties, and research schools. *History of Science* 19:20–40.
Geison, Gerald L, and Frederic Holmes eds. 1993. *Research schools: historical reappraisals. Osiris* 8. Chicago: University of Chicago Press
Gomes, Joaquim Ferreira, Rogério Fernandes, and Rui Grácio. 1988. *História da educação em Portugal*. Lisboa: Livros Horizonte.
Kohler, Robert. 2002. *Landscapes and labscapes. Exploring the lab-field border in biology*. Chicago: University of Chicago Press.
Laranjeira, Manuel F. 1992. A evolução da física atómica e molecular no século XX. In *História e desenvolvimento da ciência em Portugal no séc. XX,* 199–230. Lisboa: Academia das Ciências de Lisboa.
Leal, Maria Margarida. 2001. José Tiago de Oliveira (1928–1992). Um estatístico eminente. In *Memórias de professores cientistas,* ed. A. Simões, 144–151. Lisboa: Faculdade de Ciências da Universidade de Lisboa.
Leitão, Vanda. 2003. Bringing rocks into state bureaucracy: the Portuguese Geological Survey. In Proceedings of the 26th Symposium of the International Commission on the History of Geological Sciences. INHIGEO Meeting: Portugal 2001. Geological resources and history, ed. Manuel Serrano Pinto, 273–280. Aveiro: Centro de História e Filosofia da Ciência e da Técnica and Universidade de Aveiro.
Mañes, Xavier. 2008. Making science in the periphery: determination of crystalline structures in Spain, 1940–1955. In *Beyond borders, fresh perspectives in history of science,* ed. Josep Simon and Néstor Herran, 345–360. Newcastle: Cambridge Scholars Publishing.
Matos, Sérgio Campo de. 2013. Na Primeira República. In *A Universidade de Lisboa nos séculos XIX e XX*, Vol. 1, eds. Sérgio Campos Matos and Jorge Ramos do Ó, 78–135. Lisboa: Tinta da China.
Miranda, Pedro, and Luís Mendes Victor. 2001. José Pinto Peixoto (1922–1996). A física do clima. In *Memórias de professores cientistas,* ed. A. Simões, 183–143. Lisboa: Faculdade de Ciências da Universidade de Lisboa.
Monteiro, Aniceto. 1942. Movimento Matemático. *Gazeta de Matemática* 9:25–26.
Moreira, Rui. 2001. Cyrillo Soares (1883–1950). O início da investigação em física na FCL. In *Memórias de professores cientistas,* ed. A. Simões, 20–24. Lisboa: Faculdade de Ciências da Universidade de Lisboa.
Mota, Teresa Salomé. 2007. A mere shadow of an institution: the unhappy story of the Portuguese Geological Survey (PGS) in the period between the two World Wars. *Annals of Science* 64:19–40.
O governo resolveu afastar do serviço efetivo por motivos de ordem pública alguns oficiais e professors. 1947. *Diário de Lisboa*, 15 June.
O momento político. O problema das eleições. 1945. *Seara Nova* 948 (supplement), 13 October.
Oliveira, Tiago de. 1987. Um projeto de matemáticas aplicadas: o DEIOC. In *Faculdade de Ciências da Universidade de Lisboa: passado/presente, perspectivas futuras. 150° aniversário da Escola Politécnica/75° aniversário da Faculdade de Ciências,* ed. Fernando Bragança Gil and Maria da Graça Canelhas, 43–47. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Oliveira, Tiago de. 2001. Vicente Gonçalves (1896–1985). Um mestre de rigor e serenidade. In *Memórias de professores cientistas,* ed. A. Simões, 44–49. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Paul, Harry W. 1972. *The sorcerer's apprentice. The French scientists' image of German science, 1840–1939*. Gainesville: University of Florida Press.

Perez, Ilda, ed. 1997. *Movimento Matemático 1937–1947*. Lisboa: Câmara Municipal de Lisboa.

Publicações que permutam com a Revista da Faculdade de Ciências da Universidade de Lisboa. 1961. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Ramos, Luís A. Oliveira, Joel Serrão, and António de Oliveira. 1997. *História da Universidade em Portugal*, Vol. 1. Coimbra: Universidade de Coimbra and Fundação Calouste Gulbenkian.

Ramos do Ó, Jorge. 2013. No autoritarismo português. In *A Universidade de Lisboa nos séculos XIX e XX*, Vol. 1, eds. Sérgio Campos Matos and Jorge Ramos do Ó, 137–179. Lisboa: Tinta da China.

Resende, Flávio. 1947. Problemas de há 150 anos. *Instituto Botânico da Faculdade de Ciências* 5:1–11.

Resende, Flávio. 1948. A investigação científica e a importância nacional da universidade. *Instituto Botânico da Faculdade de Ciências* 1:1–11.

Ribeiro, António. 2001. Carlos Teixeira (1910–1982). O renascimento da geologia de campo no século XX. In *Memórias de professores cientistas,* ed. A. Simões, 90–95. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Salgueiro, Lídia, and Luísa Carvalho. 2001. Manuel Valadares (1904–1982). Facetas de uma personalidade humana, científica e artística. In *Memórias de professores cientistas,* ed. A. Simões, 70–77. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Sanchez-Ron, José M. 2002. International relations in Spanish physics from 1900 to the Cold War. *Historical Studies in the Physical and Biological Sciences* 33:3–31.

Saraiva, Luís Manuel. 2002. Pedro José da Cunha, (1867–1945), historian of Portuguese mathematics. In Studies in history of mathematics dedicated to A. P. Youschkevitch. Proceedings of the XXth International Congress of History of Science, Vol. 13, 325–337. Begijnhof: Brepols.

Schaffer, Elinor S. 1990. Romantic philosophy and the organization of disciplines: the founding of the Humboldt University of Berlin. In *Romanticism and the sciences,* ed. Andrew Cunningham and Nicholas Jardine, 38–54. Cambridge: Cambrige University Press.

Serra, José Antunes. 1957. Cultura científica e nível de vida. *Instituto Botânico da Faculdade de Ciências* 7:1–174.

Simões, Ana. 2011. O ano 1947 e o Laboratório de Física da Faculdade de Ciências de Lisboa. *Gazeta de Física* 34 (2): 16–21.

Simões Ana Ana Carneiro Maria Paula Diogo, Luís Miguel Carolino, and Teresa Salomé Mota. 2013a. *Uma história da Faculdade de Ciências da Universidade de Lisboa*. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Simões, Ana, Ana Carneiro, Maria Paula Diogo, and Luís Miguel Carolino. 2013b. Da Escola Politécnica e da Faculdade de Ciências de Lisboa. In A Universidade de Lis*boa nos séculos XIX e XX*, Vol. 2, eds. Sérgio Campos Matos and Jorge Ramos do Ó, 778–859. Lisboa: Tinta da China.

Valadares, Manuel. 1945. As faculdades de ciências devem ser reformadas porque, tal como funcionam atualmente, são, quando muito, liceus de primeira classe. República, 22 October.

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Part IV
Universities and Discipline Formation

Chapter 17
The Reforms of the Austrian University System 1848–1860 and their Influence on the Process of Discipline Formation

Christof Aichner

17.1 Introduction

This paper addresses the reform of the Austrian educational system following the revolution of 1848, which greatly influenced the formation of university disciplines during the Habsburg Monarchy.[1] Most researchers locate the starting point of the process of 'discipline formation' around 1800. Until then an hierarchic classification of scientific subjects dominated, which was afterwards replaced by a system of different disciplines that lay (theoretically) on the same level. The remaining nineteenth century is generally considered as the crucial period for the formation of disciplines. The development had two important consequences: firstly, disciplines became the central organizational units of scientific research and teaching; secondly, the emerging disciplines have continued to dominate scientific life until today—despite various claims for trans-and interdisciplinarity (Stichweh 1984; Turner 1999; Weingart et al. 2007). In Austria the process of discipline formation was belated, compared for example to neighbouring Prussia.

In the sociology of science different theoretical approaches to the process of discipline formation have emerged (Heilbron 2004; Weingart et al. 2007). A prominent example is Rudolf Stichweh (Stichweh 1984), who tried to explain discipline formation with Niklas Luhmann's systems theory (Luhmann 1970). Stichweh saw a fundamental change in science at the beginning of the nineteenth century. This change was, in Stichweh's interpretation, mainly a shift from a hierarchical organization of science to an organization based on scientific disciplines emerging from ongoing specialization and differentation. Specialization is thus the central feature

[1] The paper is based on the research project 'The correspondence of Leo Thun-Hohenstein'. For further information see www.thun-korrespondenz.uibk.ac.at.

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in the social organization of science since the nineteenth century. Disciplines are, in Stichweh's view, systems of communication, which are characterized by a common object of study and common empirical as well as methodological frameworks. Disciplines reproduce and organize themselves through internal communication and form single and closed communities, which are then institutionalized as disciplines in the framework of universities. Stichweh saw the process of discipline formation driven mainly by science—the internal process of specialization—whereas external, political or social reasons of establishing new disciplines were hardly taken into consideration. However, even if Stichweh's theory renders a methodologically sound analysis of the formation of German physics in the nineteenth century, his approach seems to focus too much on science-internal aspects. The history of science though shows prominent exceptions to such a purist view; it is especially the case with dictatorial regimes—for instance for sciences under the Third Reich and in the USSR—where the political influence on the formation of certain disciplines has been well explored (Orth et al. 2010; Graham 1993). Furthermore the sociology of science shows different examples in recent history, in which politics plays a crucial role in establishing new scientific disciplines (Weingart et al. 2007) but for the 'classical' age of discipline formation, the nineteenth century, such examples are few. In this respect, this paper presents a case where we can trace a strong political influence on the formation of certain disciplines in the middle of the nineteenth century, during the period of the reform of the Austrian University system between the years 1848 and 1860. The period and the reforms in Austrian historiography are strongly connected with the name of Leo Thun-Hohenstein, then Minister of Education and Religious Affairs.

In the first part of this paper I will describe the situation of the universities in the *Vormärz*, the decades before the March revolution in 1848, and then outline the aims of the reforms. In the second part the paper will demonstrate how the reforms of the Austrian University system paved the way for the introduction of some new disciplines to the Habsburg Monarchy. In addition we shall see how this process was caused by political and ideological reasons rather than scientific developments being initiated by Leo Thun during his tenure. The paper deals with these reasons in this special case and tries to trace the range and the limits of political influence on the process.

17.2 The Reform

At the beginning of the reforms stands the revolution of 1848 that set a drastic end to the *Vormärz*, in which the Austrian universities were trapped in deep stagnation.[2] Whereas in Prussia, universities had been reformed and redefined as places of both teaching and research, the Austrian ones remained teaching institutions for the

[2] For a general overview on the reforms see: Lentze (1962), Cohen (1996), Höflechner (2010) Surman (2012).

training of physicists and jurists. Due to the lack of scientific institutions such as an Academy of Science, research was limited to the Court Museums, Court Institutes, the Imperial Library or to local scientific societies (Höflechner 1999). So-called *Studiendirektoren* (officially appointed directors of the universities) observed the lectures in the universities, but vast censorship made it difficult for professors to publish and almost impossible for students to borrow 'dangerous' or new books from the libraries. The curriculum of the philosophical faculty was slightly reformed a few times in the course of the nineteenth century, but was largely oriented on the *ratio studiorum*[3] of the Jesuits, even when this Catholic order was suppressed in Austrian countries at the end of the eighteenth century. Furthermore students were hindered from going to universities abroad with the consequence of a very limited intellectual exchange with neighbouring countries. A vivid example of this intellectual limitation is rendered by the diaries of Adolph Pichler, a student during the *Vormärz* and from 1867 professor at the University of Innsbruck, when he writes about the study:

> The philosophical faculty was just slightly superior in rank than the gymnasium, and led us only to the threshold of a few new subjects: Geometry, logics, psychology and metaphysics—but these were dealt with only superficially. Professors were not allowed to deviate a bit from the prescribed course, even though they knew better. The university was supposed to drill us for the practical professions. (Pichler 1905, p. 96)

In addition, the largest universities of the monarchy—Vienna and Prague —were dominated by the *Doktorenkollegia*, which were more interested in financial affairs of the faculties and in controlling access to the learned professions in the cities than in scientific progress. But this antiquated system was abolished by the revolution of 1848. The Austrian students played a decisive role at the beginning of the revolution and were among the first on the barricades of the revolutionary movement. The academics were the first group to claim freedom of the press and to demand a constitution as well as a reform of the educational system (Maisel 1998). Already at the end of March 1848 Emperor Ferdinand I accepted the claims of his people: he abolished censorship, conceded freedom of teaching and learning to the universities, and established for the first time in Austria a Ministry of Education, which had the special task to work out a reform program for the Austrian educational system. Soon after his appointment, the first minister of education Franz von Sommaruga announced to the Viennese students the government's will for a radical reform of the universities, adding that the "flourishing German universities" (ct. in Engelbrecht 1986, p. 516) should serve as a model for the Austrian reform. Already in July of 1848 the Ministry presented the first concept for the reform.

A central person of this period was Professor Franz Exner, who had already been engaged in a planning committee for educational reform during the last years of the *Vormärz*. But back then his proposed plan was disregarded; only the terrifying experience of the revolution a few years later paved the way for his ideas. The already-prepared plans were discussed in public for the first time in 1848. Following

[3] This is the major collection and manual of the Jesuit educational system. It outlines goals and methods of the tuition for Jesuit schools and universities (Duminuco 2000).

Sommaruga's announcement, Exner's plan was orientated towards the Prussian reforms that today are associated with the name of Wilhelm von Humboldt.[4] The existence of a 'Humboldtian model' is in recent research increasingly seen as a myth, which never existed in the nineteenth century in the form generally known from the classical text of von Humboldt (*Über die innere und äußere Organisation der höheren wissenschaftlichen Anstalten in Berlin, 1810*). This text was recovered only around 1900 (Bruch 1999; Paletschek 2002). Therefore, it is better to speak of a Prussian model—represented especially by the Humboldt University of Berlin—that served as an example for the Austrian reformers. The German universities had been reformed after the defeat of the country by Napoleon. The newly founded University of Berlin was a particular symbol of the reform. According to Marc Schalenberg (Schalenberg 2002), the major characteristics of Prussian universities in the middle of the nineteenth century were: they were institutions of both teaching and research; the state *("Kulturstaat")* was responsible for the funding of universities and granted their academic freedom; an further important aspect of the Prussian concept was the idea of the unity of science and, accordingly, to adhere to that concept a university should cover all sciences. Especially the academic freedom and the rejection of the focus on useful sciences alone, in combination with the concept that a university should educate both students and professors through science ("*Bildung*") were the most attractive features of the Prussian universities to the Austrian reformers at that time.

Alternative suggestions for the adoption of the Prussian model (adjusted to Austrian requirements) were made, for example by Ernst von Feuchtersleben—for a short time in 1848 undersecretary in the ministry—who proposed to reform medical training using the example of the French *grandes écoles* (Egglmaier 1996). These suggestions, however, were never taken into serious consideration: an orientation on the *grandes écoles* would have meant, in the eyes of Franz Exner, considering Austrian universities as merely higher schools for the training of civil servants and physicists. Even if, as Heilbron noted, the *grandes écoles* produced "generalists rather than narrowly trained disciplinary specialist" (Heilbron 2004, p. 37), the perception of Exner was quite the opposite. Besides, the concept of specialized higher schools undermined the idea of the unity of science, favoured by Exner and other reformers. Whether the preference for the Prussian model also had political reasons is not yet sufficiently studied. One evidence for such a view might be the *Verhandlungen deutscher Universitätslehrer* (Congress of all German university professors) in autumn 1848 in Jena, which was also attended by some Austrian professors and where a unification of the universities of the German Confederation—analogue to the debates in the Frankfurt Parliament about a national unity of German states—was controversially discussed (Domrich and Häser 1848). Conversely the political implications of the transfer of a Prussian university-model can be seen in statements from Franz Exner, when he asserted that the reform would respect Austrian traditions and borrow solely the basic ideas of the Prussian reforms (Exner 1848).

[4] About the adoption of the model in other countries see Schwinges (2001), Schalenberg (2002).

During the chaotic months of the Viennese revolution and various ministerial reshuffles, Exner was the leading person in reform elaboration. Until the imperial approval of the reforms in the autumn of 1849 a range of preliminary steps was taken by the ministry, and directed by Exner. One example is the abolition of the prescribed textbooks for university professors, as well as the implementation of the habilitation and the *Privatdozenten*[5]—a position that personalizes the new character of the universities as institutions both of teaching and research. Another important measure in that period was the appointment of Prussian-born Hermann Bonitz, as professor for classical philology at the University of Vienna. His nomination was characteristic and indicative of the following period in many senses: firstly, as ministerial adviser, Bonitz designed large parts of secondary school reforms (Meister 1963); second, his appointment to a professorship in a discipline that was central in the conception of the reforms, based on the German *Neuhumanismus*; finally, he was the first in a long row of Prussian scholars to be appointed to Austrian universities during the tenure of Leo Thun-Hohenstein. This last fact rendered possible a transfer of knowledge from Prussia to the Habsburg lands.

In the summer of 1849 Leo Thun was appointed Minister of Education and Religious Affairs (*Ministerium für Kultus und Unterricht*) and soon after he proposed Exner's plans to the new Emperor Francis Joseph and was granted imperial approval. It was now Thun's task to implement the reforms. The attribution of the reform to Thun-Hohenstein seems thus justified, especially considering the fact that most of the other reform plans that emerged from the 1848 revolution were withdrawn afterwards during the neo-absolutistic era.

17.3 Leo Thun-Hohenstein: Life and Social Background

Leo Thun was born in 1811 into an old and respected aristocratic Bohemian family. In the years following his graduation from Charles University, Thun remained in Prague, starting a civil service career and becoming ever more involved with reform-orientated circles. He held the position of governor during the revolution of 1848 in Prague and in 1849 he was appointed as minister and held this position until 1860.

Thun's father Franz was an admirer and friend of the philosopher Bernard Bolzano and so Thun became familiar with Bolzano and his late-enlightenment ideas. Bolzano was a Bohemian Catholic priest and philosopher who was especially interested in logic and mathematics. A central focus of his work was a critique of Immanuel Kant's epistemology, emphasising "the importance of making a sharp distinction between the subjective and the objective, that is, between subjective ideas or representations and objective thoughts in themselves" (Luft 2010, p. 8). Recent research on Bolzano especially accentuates his intermediary position between

[5] The term '*Privatdozent*' (PD) indicates a person who holds a formal qualification to teach in universities. The title originates from German universities (cf. Pallo chap., this book). A *Privatdozent* does not have a position at a university, but is mainly paid by the fees of the students, who attend his lectures.

transcendental and analytic philosophy. Because of his liberal and enlightened position Bolzano lost his chair at Charles University and was furthermore not allowed to publish any works in Austria until his death (Luft 2010; Feichtinger 2010). In his philosophy Bolzano tried to unify Catholicism with general ideas of the enlightenment. This Bohemian reform-Catholicism was deeply interested in a reform of society, a reform that could be accomplished through an improvement of the educational system. In some ways this can be seen as a Catholic counterpart to protestant reformers such as Humboldt, Schleiermacher and Herbart (Wozniak 1995). In particular Eduard Winter (Winter 1968) and Thienen-Adlerflycht (Thienen-Adlerflycht 2003) drew a direct connection from Bolzano's ideas to Thun's reform-program. This nexus can certainly be detected in Thun's effort to conciliate faith and science. But not every idea of the reform can be explained by the influence of Bolzano, as Thienen-Adlerflycht suggests, since the reform plans were already prepared when Thun took his office, and Exner—mastermind of the plans—was influenced by Herbart rather than by Bolzano. Johann Friedrich Herbart is mostly known as the founder of pedagogy as an academic discipline; he influenced Austrian philosophy especially by integrating psychology into epistemology and by emphasizing the role of psychology for pedagogy and the learning process of children (Feichtinger 2010). However, the Bohemian environment undeniably influenced Thun with strong ties to nearby Saxony and protestant Prussia. Additionally, Thun visited Paris and London in his younger years where he was in contact with Alexis de Tocqueville, Henry Reeve and John Austin. The experiences in Britain especially affected his later ideas for a social reform in general, and reform of the penal system in particular (Thienen-Adlerflycht 2003). After returning from his tour, Thun founded, for example, a society for the social rehabilitation of released prisoners. The edited correspondence between Leo Thun and Alexis de Tocqueville (Olšákova and Fořtová 2011) shows furthermore Thun's persistent efforts for and interests in improvement of the conditions of prisoners in Austria. In addition, John Austin influenced Thun's legal thought, which, in turn, affected the reforms of legal studies in Austria with a strong focus on the study of the law that had been posited and its historic evolution (Thienen-Adlerflycht 2003). The influence of the bilingual Bohemian environment is discernable in his later policy concerning the use of different languages in schools. Additionally, following his early years as a minister, ultramontane Catholicism had a lasting effect on his work.

After his dismissal from his ministery, Thun became a member of the *Herrenhaus* (House of Lords) and a central figure of Austrian conservatism. As an editor of the conservative newspaper *Das Vaterland* (The Fatherland), he played an important role in spreading conservative thinking throughout the Habsburg Empire.

17.4 The Aims of the 1848 Reform

The central modification caused by the reform was that freedom of teaching and learning became the highest priority of the universities. The universities were now autonomous, as administration was assigned to the professors, including the right of the faculties to propose professorial appointments. In spite of this strengthening of the former corporatist character of the universities, they remained to a great extent state institutions, given that most of the decisions of the academic authorities needed ministerial approval. Moreover, the Minister of Education had the right to control the universities and to transfer professors from one university to another or to remove them from their office. The philosophical faculties were upgraded: before, they had a preparatory character and served as the link between the gymnasium and the higher faculties of law, medicine and theology. The demand to upgrade the philosophical faculty was raised first by Immanuel Kant in his *The Contest of Faculties (1798)*. In the past the 'non-reforming' of Austrian universities had been related to the fact that Kant's works were suppressed during the *Vormärz*, hence rendering impossible a wide reception of both the work and Kant's thinking. But, as Feichtinger (Feichtinger 2010) showed recently this assumption was overrated. The reform did not happen earlier because of a lack of political will and a long adherence to a utilitarian concept of university. The former preparatory task of the philosophical faculty was transferred to the gymnasiums, to which the standard enrolment period was then extended to eight years. The gymnasiums were supposed to convey higher education, dealing especially with classical languages and the preparation of students for higher university-based studies. Exner and Bonitz introduced a consistent educational structure to Austria strongly influenced by the German *Neuhumanismus* and conceptions of the Herbartian pedagogy (Meister 1963).

The revaluation of the philosophical faculty was especially crucial to the reformers. The canon of taught subjects and curriculum of this preparatory faculty remained quite constant during the *Vormärz* and was limited by censorship and political reasons. The reform opened the universities to new subjects; however, this new openness was to a great extent, although not exclusively, politically influenced.

In the following part I will outline how Thun influenced the implementation of the reform and thus affected the process of discipline formation. Through political interference the ministry was able to control most of the liberal reforms. The reasons for the attempt to control these processes can largely be traced back to Thun and his advisors' political thinking.

The tremendous experience of the revolution convinced Thun of the need for a reform of the monarchy, which is why he supported the claims of students and professors for academic freedom and a renewal of the educational system. But he did not agree with the general liberalism of most academics, rejecting it as a destructive power, not conducive to peaceful social coexistence. Thus, as a minister, he tried "to devise an educational system designed to protect and rebuild society after seventy years of stagnation" (Wozniak 1995, p. 66). His undersecretary and friend Joseph Alexander von Helfert, involved in the reforms since 1848 and responsible for some central measures and appointments of the first reform period (Surman 2012), as well as the German scholar and prominent exponent of the ultramontane movement Karl Ernst Jarcke, encouraged Thun in his planning. The latter wrote to Thun in the summer of 1849 (letter reprinted in Lentze 1962, p. 295), and gave the newly appointed minister a lot of advice for his new charge. In Jarcke's opinion, the central duty of the minister of education was to prevent another revolution like that in 1848 and to bring the Austrian youth back on the right track. In his view the only way to accomplish this was by raising the standard of Austrian schools and universities. Thun followed these suggestions in supporting the formation of some disciplines more than others, considering the ones chosen as more helpful to his plans. What followed was a balancing act between modernization and Catholic conservatism, liberalizing the general shape of the educational system and simultaneously changing the contents in a catholic-conservative direction.

This special intention of the minister and/or a lack of understanding about him, has in the past led to divergent perceptions of Leo Thun-Hohenstein. Whereas for most liberal contemporaries he was an ultramontane conservative, Thun was simultaneously criticized by stricter Catholics for being too liberal (Lentze 1962). Finally, at the end of the nineteenth century, when Austrian universities, especially the University of Vienna, were highly renowned across the scientific world, Thun was seen as the man who caused this advancement, at this time his controversial side and his "dictatorial authority" (Cohen 1996, p. 26) were entirely disregarded. The most prominent example of this sort of glorification is probably the biography of Thun by Samuel Frankfurter (Frankfurter 1893). This last perception, "the legend of the impartial count Thun" (Lhotsky 1972, p. 289), dominated historical narratives until the early 1950s, a fact that became particularly obvious at the end of World War II, when Austrian universities tried to forget the seven years of National Socialism and their keen backing of the regime. In this situation Richard Meister, rector of the University of Vienna in 1949, emphasized the idea of freedom of teaching and learning and considered Leo Thun as the first advocate of these rights (Meister 1949). Here, Leo Thun served in a way as an anti-totalitarian role model who was detached from the ideological exploitation of the universities by the Nazis. Simultaneously the recourse on Leo Thun, for example in a paper of Heinrich Drimmel (Drimmel 1959), at that time Minister of Education, had another important role, which was to stress the existence of a proper Austrian university-model, again in order to create distance from the disastrous unity with Germany in the Third Reich. The perspective only changed with the research of Hans Lentze (Lentze 1955, 1959, 1962), who demonstrated for the first time Thun's plan to 're-educate' the Austrian youth through the implementation of a rigid conservatism to the universities as well as showing Thun's control of the universities. In this way—ironically—drawing on the tradition of Leo Thun after World War II nevertheless made sense, but different from the intended way, drawing rather a parallel between the re-education of Austrian youth after the revolution of 1848 and the Allied re-education efforts after the defeat of the Third Reich. Since the research of Hans Lentze, several detailed studies (Lhotksy 1972; Mazohl-Wallnig 2000; Höflechner 2010) support Lentze's perspective.

17.5 The Implementation of Reforms and their Influence on Discipline Formation

In Thun's eyes the re-education of Austrian students could be achieved by means of supporting certain disciplines, which would positively affect the attitude of the students, and vice versa by suppressing others that would not do so. An example of this program is Thun's promotion of legal history and the simultaneous suppression of legal philosophy. He attached little value to the latter subject, or even blamed legal philosophy—as liberal and relativist forces—for causing revolutionary thinking among the students (Thun-Hohenstein 1855). Until 1848 several chairs of legal philosophy existed at Austrian universities, but since 1849 the number was reduced by Thun's policy of not filling vacant one or transferring professors to other chairs. In 1855 the ministry even changed the curriculum for the studies of jurisprudence, excluding legal philosophy from the examination subjects. Hence legal philosophy finally lost its attraction for students. In this way Thun, within a few years, achieved the almost entire and long-lasting removal of legal philosophy from Austrian universities (Feichtinger 2010).

Conversely to the oppression of legal philosophy, Thun supported the implementation of the historical school of law and the study of Roman law. The focus on study of the historical development of German and Austrian law was supposed to help build a firewall against, in his eyes, the dangerous speculative philosophy and natural law. The study of the evolution of law could reveal the historic origins and especially the influence of Christianity on pagan Roman law, whereas in Thun's interpretation natural law undermined this Christian influence and, by implication, also the Christian basis of the state (Thun-Hohenstein 1855). Furthermore, Thun was convinced that there was a sort of spiritual connection between a nation and its historically evolved law—natural law by contrast would corrupt such a connection and destroy the traditions for a peaceful communal life of the nation. To this end the minister appointed several (German) scholars, each of whom were to teach this matter to Austrian students. One of Thun's first professorial appointments was the call of George Phillips to the newly created chair of History of Law at the University of Innsbruck. Phillips was a prominent German ultramontane and a close friend of Jarcke, who had suggested his former colleague to Thun. Additionally, Phillips was a pupil of Karl Friedrich von Savigny, founder and icon of the German historical school of Law. Hence the nomination of Phillips set the agenda for the following period, with several appointments of Catholic historians of law and the build-up of an Austrian (and Catholic) tradition of legal history studies. Phillips was soon transferred to Vienna, and his successor in Innsbruck was another well-known ultramontane, Ernst von Moy, previously professor in Munich. Von Moy, as well as Phillips, had lost their positions at the University of Munich during the affair with Lola Montez (Lentze 1970; Leisching 1986). Other conservative or even ultramontane scholars followed, resulting in the establishment of at least one chair of history of law at almost all Austrian universities by the end of Thun's term. Similarly to the elimination of legal philosophy, the promotion of history of law was accomplished by changing the curriculum in 1855, when the studies of Roman law and legal history achieved a major role within the faculty of jurisprudence.

The promotion of legal history came along with an increased general focus on historical studies. History was not an invention of the nineteenth century, but from around 1800 we can trace a process of professionalization, expressed especially in the critical dealing with historical sources and methodological debates.[6] This

[6] An early but regional version of this process was the school of St. Maur in France with the foundation of diplomatics. For effects on Austria during the eighteenth century see the project on

process is strongly connected with the name of the Prussian historian Johann Gustav Droysen and occurred belatedly in Austria. Here historiographers adhered to pre-professional historiography longer than in Germany. Within the universities historiography formed part of propaedeutic studies in the lower faculty until 1848, at that time referred to as *Allgemeine Weltgeschichte* or *Universalgeschichte* (Universal History) or later on as *Welt- und Österreichische Staatengeschichte* (World History and History of the Austrian States) (Mazohl and Kuprian 2008). There was no possibility to study history as a major subject, which is why the teachers of this subject were predominantly autodidacts (Mazohl and Wallnig 2009). In many cases these historiographers were Catholic monks.

1848 marks the point of change from an individualistic and mostly narrative historiography to an organized and institutionalized historical science (Fellner 2002; Pischinger 2000). Within every Austrian university a chair for the teaching of history in general and one for Austrian history in particular was installed. Thun and his undersecretary Alexander Helfert thought a genuine Austrian history helpful to generate and spread national feeling among the people of the Empire and, in turn, important to avoid such experiences as the 1848 revolution in the future. The construction of a national tradition that was based on historical research and consisted of a common narrative was to oppose liberalism and contribute to develop a new basis for a peaceful living together of different peoples within the Habsburg Empire. For this reason Thun also founded an *Institute for Austrian Historical Research* (IAHR), where graduates could get special training in methods of historical sciences (Lhotsky 1954; Surman 2012).

As there were only a few people able to fill all the new chairs, Thun had to appoint scholars from abroad, especially from Prussia; people who had already been educated in a critical historical science and could impart this knowledge to Austrian students. Thus a transfer of disciplinary knowledge was possible and simultaneously this (Prussian) knowledge helped to create a proper Austrian narrative alternative to the Prussian.

A third example given here is the Slavic studies and chairs for Slavic languages. Already in 1848—prior to Thun's tenure—two chairs for Slavic studies had been established at the University of Vienna and the University of Prague, and other universities followed. Until 1848 teachers or even university professors only taught Slavic languages but did not operate on a scientific level. Efforts for a scientific approach to understanding Slavic languages had been made outside the universities since the rise of Romanticism at the beginning of the nineteenth century and were carried out mainly by autodidacts, above all Jernej Kopitar und Josef Dobrovsky (Hafner 2003). Kopitar profited from and was highly influenced by his contact with Jakob Grimm, founder of German language studies, especially regarding methodical approaches. With the installation of the two chairs for Slavic Studies at the University of Vienna the first step to a scientific approach was made. As with the promotion of history, the build-up of Slavic studies was supposed to provide practical use for the multinational monarchy (Surman 2012). Secondly, it could be understood as a concession

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Benedictine historiography: http://www.univie.ac.at/monastische_aufklaerung/en/startseite.html.

to the many Slavic people across the Habsburg monarchy after their revolt in 1848; this was also helpful to settle the different national feelings and express the political equality of all the people of the empire (Hafner 2003). At the same time the ministry was aware that an appointed professor would not use his position and the Slavic studies to spread national feelings. The appointment of Franz Miklosich as one of the first professors of Slavic languages might have been an expression of this concern, because Miklosich addressed a more positivistic categorizing of Slavic languages than a romantic study of Slavic literature. The appointments of Jan Kollar and Karol Kuzmany to the University of Vienna also show the preference for moderate Czech nationalists. Whereas, for example, the prominent Czech nationalist Franitsek Palacky, despite being a leading intellectual figure of the Monarchy was not appointed to the chair of history in Prague (Surman 2012); Thun preferred in this case the moderate Vaclav Tomek instead. Furthermore, the implementation of Slavic studies shows parallels to the introduction of other philological disciplines, for instance the chairs for German literature and language, which were established shortly after the creation of the chairs for Slavic studies. The first were created at the universities of Prague and Vienna, where the initially appointed Theodor Karajan soon resigned and was succeeded by Karl August Hahn. Thun's special interest in Catholic scholars once more becomes obvious in the appointment of Oskar Redwitz to the second chair in this field in Vienna. Redwitz was a prominent German poet and 'preacher' for a Christian spiritual reawakening. In his proposal to the Emperor for the appointment of the poet, Thun emphasized the role of the studies of German literature, as a Christian counterpart to pagan classical philology (Thun-Hohenstein 1852).

In the above examples the establishment of certain disciplines was primarily supported for ideological reasons. Another important purpose for the support of some disciplines was the political will to initiate a technological modernization of the country. For example, the polytechnic schools, which later became institutes of Technology (*Technische Universitäten*), were massively expanded (Cohen 1996). Moreover, emerging disciplines like chemistry were introduced to most Austrian universities. Until 1849 chemistry was part of medical training but in the course of the reforms it was separated from this study and established as a separate discipline within the philosophical faculty. The "nucleus of teaching and researching" (Rosner 2004) of modern chemistry was the laboratory of Josef Redtenbacher at the University of Prague. Redtenbacher was already a visiting researcher in the laboratory of Justus Liebig during the *Vormärz* and had spread his acquired knowledge among his students in Prague. During the term of Leo Thun a number of his students were called to chairs at several Austrian universities and polytechnics (Rosner 2004).

Whereas the creation of chairs for Slavic and/or German languages and literature at most of the Austrian universities caused a gradual disciplinary development, the teaching of other languages—French and English for instance—remained in a pre-scientific form for many decades. Hence, within the philosophical faculty a separation occurred between scholars teaching a scientific subject and scholars who trained the students in supporting skills and languages, such as English or Italian, or statistics and sports. This change also triggered a discussion of personal and social status and prestige, because some former professors of the 'old' philosophical faculty had been reduced in rank while other professors of the renewed philosophical faculty were put on a par with the professors of the higher faculties and assumed new social prestige and financial rewards.

17.6 Networks

As the examples indicate, Thun paid much attention to the choice of the right person to fill each chair. Additionally, Thun targeted a renewal of teaching staff: on the one hand this was to remove the elder professors, who in many cases did not have the qualifications to satisfy the new requirements; on the other hand Thun tried to appoint a new generation of highly qualified and conservative Catholic scholars (Surman 2012). To acquire new professors Thun had a widespread network of advisors, who gathered and provided information about possible candidates for professorships. The preserved correspondence of the minister shows this impressively: most of the letters to be found in various Austrian and foreign archives deal with questions about probable candidates.[7] Additionally, Thun's advisors wrote to their friends and colleagues to ask for information or recommendations to the minister.

The appointments at the University of Innsbruck during Thun's tenure demonstrate this point well. They not only show how many people were involved in the process of any single appointment, but furthermore they also illustrate which requirements a candidate had to fulfil, especially for ideologically important disciplines. In this respect, the case of Innsbruck is particularly interesting, and to some extent special, since the Catholic environment in the Tyrol was very rigid and plans were made to transform the university into a proper Catholic institution.[8] Other cases show a similar pattern, especially the appointment of historians, philosophers and classical philologists were well considered and often carefully secured by different recommendations.

Thun's network and his personnel policy also allowed the transfer of scientific knowledge and methods to the Habsburg Monarchy. Since the number of chairholders was very limited at the time, the call of just a few professors from Germany would cause profound effects in this regard. The best-known example is the spreading of the historical method of jurisprudence against a natural law theory, which particularly dominated Austrian jurisprudence after 1811, when the Austrian Civil Code *(Allgemeines Bürgerliches Gesetzbuch—ABGB)* was enacted and a new study plan was introduced to the universities. Prior to 1848 there were only a few scholars representing the historical school of law in Austria. By contrast, after the reforms of Thun-Hohenstein, this school for a time dominated Austrian jurisprudence. Much

[7] Most of the letters will be published on the website of the research project 'The correspondence of Leo Thun-Hohenstein': www.thun-korrespondenz.uibk.ac.at.

[8] The case of Innsbruck is discussed in detail in my dissertation Christof Aichner, Die Umsetzung der Thun-Hohensteinschen Universitätsreformen an der Universität Innsbruck 1848–1860.

the same is true for the historical-critical method in history and the classical philology, which was spread in Austria after the reforms, especially by the appointment of German scholars. During his term, Thun called at least one German (Catholic) historian to every university of the country—only the chairs for Austrian history were reserved for Austrian-born historians (Surman 2012). Even at the newly founded *Institute for Austrian Historical Research (IAHR),* one of Thun's and his undersecretary von Helfert's favourite projects, Thun called the German historian Theodor Sickel, who was a specialist for the auxiliary sciences of history. Sickel studied in Berlin and Halle, and after 1848 he spent five years in Paris at the *École des Chartes*. In 1855 he was appointed assistant professor with the special task to teach auxiliary sciences of history. From 1869 he was director of the IAHR when he transformed the institute into a centre of diplomatics and paleography of international reputation. A second task of the institute was to publish important documents of Austrian history, following the example of the *Monumenta Germaniae Historica*[9]. Sickel was also a pioneer in using photography for historical research (Lhotsky 1954; Surman 2012).

The reconstruction of Thun's network illustrates his strong ties to the German Catholic elite, hoping for a golden age of Catholic science and establishing in Austria a Catholic counterpart to the leading Prussian protestant universities. The scientific recovery in Austria was also a chance for many Catholic scholars who had been hindered in their careers in Prussia because of their religious convictions.

The personnel policy and Thun's network show parallels to the policy of Friedrich Althoff (Brocke 1988; Surman 2012; Rebenich and Franke 2012), who was head of department in the ministry of education in the German Empire at the end of the nineteenth century. Like Thun, Althoff intervened in the right of faculties to appoint professors, thus affecting the mobility and careers of several Prussian scholars, the university system as a whole, and the development of single disciplines.

17.7 Concluding Remarks

This paper aimed to outline how the educational reforms of Leo Thun-Hohenstein influenced the development of Austrian universities in general and of some disciplines in particular. The reform led, within the scope of science, to a catching-up-process with other countries. Reform of the educational system and alignment with the Prussian model contributed to a dynamic development of the formerly static universities. The reform and academic freedom laid the basis for later expansion of the Austrian university system and to a general modernization of the country. The reform also fostered an expansion of the educational system. Looking for instance at the numbers of chairs in the University of Innsbruck, the dynamic of the process becomes obvious. During the term of Minister Thun the number of chairs belonging to the philosophical faculty increased by half and then doubled another ten years

[9] For information on the Monumenta Germaniae Historica see http://www.mgh.de/.

later. Other universities do not show such high rates of increase, but at every university the number of chairs, assistant professors and *Privatdozenten* increased in the following decades. Through the appointment of many professors from Prussia, a certain knowledge transfer occurred and therefore the formation of some disciplines had strong connections to developments in Prussia. Reform was in large part a generation change: most of the older professors were dismissed; newly appointed professors were often young and ambitious academics.

One aim of the paper was to show how the process of discipline formation was politically influenced. Rudolf Stichweh in his sociological approach to the process of discipline formation saw especially scientific reasons and specialisation as the central factors for the formation of disciplines. The presented example of the reforms under Minister Leo Thun aimed to show that—as opposed to Stichweh's view—not only exclusively scientific reasons and the setting of disciplinary boundaries by scientists themselves but rather ideological reasons and political decisions, especially Leo Thun's specific personnel policy influenced the process of discipline formation. Hence the formation of disciplines, at least in the presented era, was to a great degree politically dictated, especially due to the preferences of Leo Thun-Hohenstein and his advisors. They considered some subjects helpful for a general reform of the Austrian Monarchy and associated practical benefit with these. Hence the newly achieved academic freedom was a priori limited by an implicit focus on useful sciences. Examples were given of studies of Slavic and German languages, which were established early, whereas other philological studies or subjects were not established as a discipline but still instructed as supporting skills. Other examples given were the supporting of the historical school of law and the consequent suppression of natural law, which Thun considered as an anti-Christian and rationalist ideology.

Only with the dismissal of Leo Thun could the political influence diminish and the science internal processes—as analysed by Stichweh—evolve. Then the disciplines developed mainly autonomously and adopted a course often not indented by Leo Thun. Hence the political and social benefits of the established disciplines did not occur in every case. The abovementioned Slavic studies to some extent turned out to be a powder keg for the national conflicts within the Habsburg Empire. Austrian History could not really help to form a true national feeling in the multinational country. The newly founded Institute for Austrian Historical Research, originally meant to train young researchers and prepare a major national history for the public at large, became a centre of diplomatics and had little social effects whereas the philosophical faculty was, over the long-term, reassessed and Philosophy itself was 'disciplined' losing its universal character as a sort of meta-science. This caused a general positivism and a lack of theoretical framework in many disciplines, which for a long time affected scientific research in Austria (Feichtinger 2004). On the other hand this underlines Stichweh's view that disciplines, once they are established, operate as closed systems of communication and follow their own disciplinary logic. The governance of disciplines from the outside is then difficult.

Ultimately, this historic episode and the failed attempt to control the process of discipline formation and disciplinary evolution are relevant to current discussions in science policy. Whether academics or government should decide about research directions and the promotion of new disciplines and the extent to which their decisions affect the development of the disciplines they attempt to influence is a major dichotomy.

Archival Collections

Austrian State Archives, Allgemeines Verwaltungsarchiv, Ministerium für Cultus und Unterricht (MCU); Leo Thun-Hohenstein, 8. September 1855, Proposal to the Emperor, AVA, MCU Allg., Sig. 5, Fasz. 995; Leo Thun-Hohenstein, 11. January 1852, Proposal to the Emperor (concept), AVA, MCU Präs., 18/1852.

State Regional Archives Litoměřice—Děčín; Nachlass Leo Thun. A3 XXI

References

Brocke, Bernhard. 1988. Von der Wissenschaftsverwaltung zur Wissenschaftspolitik. Friedrich Althoff (19.2.1839–20.10.1908). *Berichte zur Wissenschaftsgeschichte* 11:1–26.

Bruch, Rüdiger vom. 1999. Friedrich-Wilhelms-Universität Berlin: Vom Modell "Humboldt" zur Humboldt-Universität 1810 bis 1949. In *Stätten des Geistes: Große Universitäten Europas von der Antike bis zur Gegenwart,* ed. Alexander Demandt, 257–278. Cologne: Böhlau.

Cohen, Gary B. 1996. *Education and middle-class society in Imperial Austria,* 1848–1918. West Lafayette: Purdue University Press.

Domrich, Ottomar, and Heinrich Häser. 1848. *Verhandlungen deutscher Universitätslehrer über die Reform der deutschen Hochschulen in der Versammlung zu Jena vom 21. bis 24. September 1848*. Jena: Frommann.

Drimmel, Heinrich. 1959. Die Hochschulreform von Thun-Hohenstein. *Österreich in Geschichte und Literatur* 3, Sonderheft Österreich 1848–1918:1–7.

Duminuco, Vincent J., ed. 2000. *The Jesuit Ratio studiorum: 400th anniversary perspectives*. New York: Fordham University Press.

Egglmaier, Herbert H. 1996. Reformansätze vor der Thunschen Reform. *Mitteilungen der österreichischen Gesellschaft für Wissenschaftsgeschichte* 18:59–85.

Engelbrecht, Helmut. 1986. *Geschichte des österreichischen Bildungswesens: Erziehung und Unterricht auf dem Boden Österreichs* 4. Vienna: Österreichischer Bundesverlag.

Exner, Franz. 1848. Die Reformen des öffentlichen Unterrichts in Oesterreich. *Constitutionelle Donau-Zeitung*, 20, 22, 26, 29 April 1848.

Feichtinger, Johannes. 2004. Positivismus in der österreichischen Philosophie: Ein historischer Blick auf die frühe Positivismusrezeption. *Newsletter Moderne. Zeitschrift des Spezialforschungsbereichs Moderne—Wien und Zentraleuropa um 1900* 7 (2): 24–29.

Feichtinger, Johannes. 2010. *Wissenschaft als reflexives Projekt*. Bielefeld: [Transcript] Science Studies.

Fellner, Fritz. 2002. Geschichte als Wissenschaft: Der Beitrag Österreichs zur Theorie, Methodik und Themen der Geschichte der Neuzeit. In *Geschichte der österreichischen Humanwissenschaft*. 4: *Geschichte und fremde Kulturen,* ed. Karl Acham, 161–213. Vienna: Passagen Verlag.

Frankfurter, Salomon. 1893. *Graf Leo Thun-Hohenstein, Franz Exner und Hermann Bonitz*. Vienna: Alfred Hölder.

Graham, Loren R. 1993. *Science in Russia and the Soviet Union: A short history*, 1st ed. Cambridge history of science. Cambridge: Cambridge University Press.

Hafner, Stanislaus. 2003. Wissenschaftliche Konzeptionen und außerwissenschaftliche Tendenzen in der Geschichte der österreichischen Slawistik. In *Geschichte der österreichischen Humanwissenschaften*. 5: Sprache, Literatur und Kunst, ed. Karl Acham, 293–322. Vienna: Passagen Verlag.

Heilbron, Johan. 2004. A regime of disciplines: Toward a historical sociology of disciplinary knowledge. In *The dialogical turn,* eds. Charles Camic and Hans Joas, 23–42. Oxford: Rowman & Littlefield Publishers.

Höflechner, Walter. 1999. Österreich: eine verspätete Wissenschaftsnation? In *Geschichte der österreichischen Humanwissenschaften*. 1: *Historischer Kontext, wissenschaftssoziologische Befunde und methodologische Voraussetzungen,* ed. Karl Acham, 93–114 Vienna: Passagen Verlag.

Höflechner, Walter. 2010. Nachholende Eigenentwicklung? Der Umbau des habsburgischen Universitätssystems nach der Mitte des 19. Jahrhunderts. In *Die Berliner Universität im Kontext der deutschen Universitätslandschaft um 1800, um 1860 und um 1910. Schriften des Historischen Kollegs*. Kolloquien 76, ed. Rüdiger vom Bruch, 93–108. Munich: Oldenbourg.

Leisching, Peter. 1986. Aus der Zeit des Aufstiegs der österreichischen Kirchenrechtswissenschaft. In *Festschrift Nikolaus Grass: Zum 70. Geburtstag dargebracht von Fachkollegen und Freunden,* ed. Kurt Ebert, 303–316. Innsbruck: Wagner.

Lentze, Hans. 1955. Graf Thun und die deutsche Rechtsgeschichte. *MIÖG* 63:500–521.

Lentze, Hans. 1959. Graf Thun und die voraussetzungslose Wissenschaft. In *Festschrift Karl Eder zum siebzigsten Geburtstag,* ed. Helmut J. Mezler-Andelberg, 197–209. Innsbruck: Wagner.

Lentze, Hans. 1962. Die Universitätsreform des Ministers Graf Leo Thun-Hohenstein. In *Sitzungsberichte*. Abhandlung 239, 2, ed. Österreichische Akademie der Wissenschaften, 1–372. Vienna: Böhlau.

Lentze, Hans. 1970. George Phillips, der große Kanonist des 19. Jahrhunderts. In *Festschrift Franz Loidl zum 65. Geburtstag,* ed. Viktor Flieder, 160–166. 1. Vienna: Hollinek.

Lhotsky, Alphons. 1954. *Geschichte des Instituts für Österreichische Geschichtsforschung 1854–1954: Festgabe zur Hundert-Jahr-Feier des Instituts. Mitteilungen des Instituts für Österreichische Geschichtsforschung Ergänzungsband* 17. Graz: Böhlau.

Lhotsky, Alphons. 1972. Das Ende des Josephinismus: Epilegomena zu Hans Lentzes Werk über die Reform des Ministers Grafen Thun. In *Aufsätze und Vorträge*. 3, Historiographie, Quellenkunde, Wissenschaftsgeschichte, eds. Hans Wagner and Heinrich Koller, 258–290. Munich: Oldenbourg.

Luft, David S. 2010. Austrian intellectual history before the Liberal Era: Grillparzer, Stifter, and Bolzano. Twenty-fifth Annual Robert A. Kann Memorial Lecture. *Austrian History Yearbook* 41:1–10.

Luhmann, Niklas. 1970. Selbststeuerung der Wissenschaft. In *Soziologische Aufklärung: Aufsätze zur Theorie sozialer Systeme, ed. Niklas Luhmann,* 232–252. Köln: Westdeutscher Verlag.

Maisel, Thomas. 1998. *Alma mater auf den Barrikaden: Die Universität Wien im Revolutionsjahr 1848*. Vienna: WUV-Universitätsverlag.

Mazohl, Brigitte, and Hermann J. W. Kuprian. 2008. Das Fach "Österreichische Geschichte" an der Universität Innsbruck: Traditionen und Perspektiven. In *Was heißt "österreichische" Geschichte? Probleme, Perspektiven und Räume der Neuzeitforschung. Wiener Schriften zur Geschichte der Neuzeit* 6, ed. Martin Scheutz, 51–71. Innsbruck: Studien Verlag.

Mazohl, Brigitte, and Thomas Wallnig. 2009. (Kaiser)haus—Staat—Vaterland? Zur "österreichischen" Historiographie vor der "Nationalgeschichte". In *Nationalgeschichte als Artefakt. Zentraleuropa-Studien* 22, eds. Hans P. Hye, Brigitte Mazohl, and Jan P. Niederkorn, 45–72. Vienna: Verlag der österreichischen Akademie der Wissenschaften.

Mazohl-Wallnig, Brigitte. 2000. Der Einfluss Bolzanos und der Bolzanisten auf die österreichische Universitätsreform der Jahre 1848/49. In *Bernard Bolzano und die Politik: Staat, Nation und Religion als Herausforderung für die Philosophie im Kontext von Spätaufklärung, Frühnationalismus und Restauration. Studien zu Politik und Verwaltung* 61, ed. Helmut Rumpler, 221–246. Vienna: Böhlau.

Meister, Richard. 1949. Die Universitätsreform des Ministers Graf Thun-Hohenstein: Inaugurationsrede gehalten am 23. November 1949. In *Die feierliche Inauguration des Rektors der Wiener Universität für das Studienjahr 1949/50,* 85–100. Vienna: Selbstverlag der Universität.

Meister, Richard. 1963. Entwicklung und Reformen des österreichischen Studienwesens: Teil I: Abhandlung. *Sitzungsberichte der Akademie der Wissenschaften, Philosophisch-Historische Klasse* 239, 1. Abhandlung, Teil I, 1–275. Vienna: Böhlau.

Olšáková, Doubravka, and Hana Fořtová. 2011. *Lev Thun—Alexis de Tocqueville*. Prague: Oikoymenh.

Orth, Karin, ed. 2010. *Die Deutsche Forschungsgemeinschaft 1920–1970: Forschungsförderung im Spannungsfeld von Wissenschaft und Politik*. Beiträge zur Geschichte der Deutschen Forschungsgemeinschaft 4. Stuttgart: Steiner.

Paletschek, Sylvia. 2002. Die Erfindung der Humboldtschen Universität. *Historische Anthropologie* 10 (2): 183–205.

Pichler, Adolf. 1905. *Zu meiner Zeit: Schattenbilder aus der Vergangenheit*. München: Georg Müller.

Pischinger, Gudrun. 2000. Vom "Dilettanten" zum Fachwissenschaftler: Die historische Kommission der österreichischen Akademie der Wissenschaften 1847–1877 und die Professionalisierung der Geschichtswissenschaft. *Mitteilungen der österreichischen Gesellschaft für Wissenschaftsgeschichte* 20:221–242.

Rebenich, Stefan, and Gisa Franke. 2012. *Theodor Mommsen und Friedrich Althoff: Briefwechsel 1882–1903*. Deutsche Geschichtsquellen des 19. und 20. Jahrhunderts 67. Munich: Oldenbourg.

Rosner, Robert W. 2004. *Chemie in Österreich 1740–1914*. Beiträge zur Wissenschaftsgeschichte und Wissenschaftsforschung 5. Vienna: Böhlau.

Schalenberg, Marc. 2002. *Humboldt auf Reisen? Die Rezeption des "deutschen Universitätsmodell" in den französischen und britischen Reformdiskursen (1810–1870)*. Veröffentlichungen der Gesellschaft für Universitäts-und Wissenschaftsgeschichte 4, ed. Rainer C. Schwinges. Basel: Schwabe & Co.

Schwinges, Rainer C., ed. 2001. *Humboldt international: Der Export des deutschen Universitätsmodells im 19. und 20. Jahrhundert*. Veröffentlichungen der Gesellschaft für Universitäts-und Wissenschaftsgeschichte 3. Basel: Schwabe & Co.

Stichweh, Rudolf. 1984. *Zur Entstehung des modernen Systems wissenschaftlicher Disziplinen: Physik in Deutschland 1740–1890*. Frankfurt: Suhrkamp.

Surman, Jan. 2012. *Habsburg Universities 1848–1918. A biography of space*. Phil. Diss., University of Vienna .

Thienen-Adlerflycht, Christoph. 2003. Graf Leo Thun-Hohenstein als nachjosephinischer Vorkämpfer eines aufgeklärten Konservativismus. In *Konservative Profile: Ideen & Praxis in der Politik zwischen FM Radetzky, Karl Kraus und Alois Mock,* ed. Ulrich E. Zellenberg, 103–168. Graz: Stocker.

Turner, Stephen. 1999. What are disciplines? And how is interdisciplinarity different? In *Practising interdisciplinarity,* eds. Peter Weingart and Nico Stehr, 46–65. Toronto: University of Toronto Press.

Weingart, Peter, Martin Carrier, and Krohn Wolfgang. 2007. *Nachrichten aus der Wissensgesellschaft: Analysen zur Veränderung der Wissenschaft*. Weilerswist: Velbrück.

Winter, Eduard. 1968. *Frühliberalismus in der Donaumonarchie: Religiöse, nationale und wissenschaftliche Strömungen von 1790–1868* (Beiträge zur Geschichte des Religiösen und wissenschaftlichen Denkens 7). Berlin: Akademie-Verlag.

Wozniak, Peter. 1995. Count Leo Thun: A conservative savior of educational reform in the decade of neoabsolutism. *Austrian History Yearbook* 26:61–81.

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Chapter 18
The Physics Laboratory of Leiden University

Dirk van Delft

'History is repeating itself, but it will cost more.' This apt quote from the Icelandic author Halldór Laxness (1902–1998) certainly applies to the Physics Department of Leiden University. An independently operating university physics laboratory in a separate building is no longer considered expedient in the twenty first century, with its large-scale, international and cross-discipline collaborations. The Leiden Physics department, which is currently housed in an unassuming building complex on the outskirts of the city (Huygens Laboratory, Kamerlingh Onnes Laboratory and Oortgebouw), is getting ready for a move to an impressive university location that will accommodate the entire science faculty. This is expected to be completed in 2022. This is an operation that shows vision and ambition, and at the same time one that has taken place before. In 1859 the Leiden Physics Cabinet together with the Leiden departments of Anatomy, Physiology and Chemistry moved into the new building at Steenschuur, beautifully situated in the inner city. Then, too, improving quality was the motive (Otterspeer 1992, p. 122). In the new building, opposite Van der Werff Park, splendid feats have been accomplished and pioneering discoveries made, such as the liquefaction of helium (1908) and the discovery of superconductivity (1911), both by Heike Kamerlingh Onnes. Reason enough to look back at how all this happened and in what context this all took place.

The Leiden Physics Cabinet dates back to 1675, when the professor of philosophy Burchard de Volder (1643–1709) was given permission to set up a small house as the Theatrum Physicum (Clercq 1997) at Nonnensteeg, next to the *Hortus Botanicus* botanical gardens. The previous year De Volder had visited the Royal Society in London. Robert Boyle's experiments with the vacuum pump made such an impression that he was resolved to introduce the experimental method into his classes in Leiden—which made him a forerunner in the Netherlands (Wiesenfeldt 2002, pp. 66–67). The first 5 years of his cabinet De Volder spent 2500 guilders (an amount as big as twice his annual income) to buy instruments to clarify 'the truth

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and certainties of those propositions and theories presented to Physics students' (*de waerheyt ende seekerheyt van die stellingen ende leeren, die in Physica theoretica de studenten werden voorgehouden*) using experimentation. It was remarkably lucky that brass-founder Samuel van Musschenbroek (1648–1681) from Leiden happened to be an extraordinarily skilled instrument maker.

In 1742 the Leiden Physics Cabinet was in one go elevated to the largest collection of instruments in the world when the governors bought the beautiful private collection of Professor Willem Jacob 's Gravesande who had died that year.[1] For years Gravesande had given lectures at his home at Rapenburg in which he, using experiments, propagated the teachings of Newton; Voltaire, too, was educated in Leiden (Maas 2012). Many of those experiments were described in his textbook *Wiskundige grondbeginselen der natuurkunde, door proefondervindingen gestaafd, of inleiding tot de Newtoniaanse wijsbegeerte*.[2] It became an international success and provided instrument-maker Jan van Musschenbroek (Samuel's cousin) with a great deal of work. When the collection of 's Gravesande was transferred to the Physics Cabinet, there was an immediate and acute shortage of space. In order to find decent housing for the expanded collection the 'cramped and damp instrument room' (*bekrompen en vogtigh instrumentkamertje*) at the Nonnensteeg was expanded by including the adjacent little house (Otterspeer 1992, p. 99).

In the nineteenth century the Leiden Physics Cabinet began to lag behind. There ceased to be professors at Leiden of the same stature as Gravesande and Petrus van Musschenbroek (Jan's brother). What's more, in the second half of the eighteenth century the heart of scientific operations had shifted from universities to societies such as the Royal Holland Society of Sciences and Humanities, Teyler's Foundation (both in Haarlem) and the *Bataafsch Genootschap voor Proefondervindelijke Wijsbegeerte* (Batavian Association for Experimental Science in Rotterdam). In 1824 the Cabinet of Scientific Instruments, as the Leiden Physics Cabinet was called by then, moved to new accommodation on the corner of Papengracht and Houtstraat (now part of the National Museum of Antiquities).

This location, too, was far from ideal. When Pieter Rijke, appointed Professor of Physics in 1845, was based there for a year, he complained that even second-rate institutions had better accommodation (Otterspeer 1992, p. 121). 'The teacher,' said Rijke, 'is often unable to see the movements of the instruments and has to ask his students what is happening, who can only give him a sufficient answer when the weather is fine.'[3] But it was the constant complaints about the laboratory of chemist Van der Boon Mesch that stirred governors into action (Otterspeer 1992, pp. 121–122). On 13 February 1851, 21 residents from Leiden, among whom a number of manufacturers, wrote that there were far too few seats to follow the lectures of Van der Boon Mesch. 'Due to pushing and shoving and the distance,' said

[1] Nowadays the Leiden Physics Cabinet belongs to the core collections of Museum Boerhaave, the Dutch National Museum for the History of Science and Medicine.

[2] English edition: Mathematical Elements of Natural Philosophy, Confirm'd by Experiments: or, An introduction to Sir Isaac Newton's philosophy (Volume I and II), 1747.

[3] Rijke to curatoren, 14 April 1846, UB Leiden, Archief Curatoren II, inv. no. 105, bijlage 78.

the twenty-one, 'a great many of those in the audience cannot see the experiments and the examples, which contribute so much to clarifying the spoken word, so that one usually misses the demonstration.'[4] Students, too, complained: they felt that the chemistry laboratory was totally unsuitable for practicals. The board of governors was unable to ignore the complaints, and so the way was paved for the newly constructed building at Steenschuur.

A 'monstrum horrible visu,' is how the Leiden Student Yearbook of 1860 characterised the brand new building for chemistry, physics, anatomy and physiology. The Steenschuur site had been a wasteland since the catastrophe in 1807 when a ship loaded with gunpowder had exploded. It was here that a building in eclectic style, designed by court architect Henri Camp (Otterspeer 1992, p. 122), was constructed for the sum of 115,767 guilders. This project was originally budgeted at 200,000 guilders but the Minister thought that was too expensive. The festive opening of the complex was held on 20 October 1859 but not everybody had the same opinion of the aesthetic result. One local periodical enthusiastically mentioned 'wide corridors and elegant staircases' (Jorissen 1909, pp. 3–4). Students, however, saw it differently (Leidsche Studenten-Almanak 1860, p. 163).

The building soon turned out to be too small. The situation improved slightly when in 1867 the Physiology department was given its own laboratory, directly behind the building. A wing for the Anatomy department was then built at an angle at the back, and the Chemistry and Physics departments shared the main building. Once the chemists had moved into their own organic and inorganic laboratories in 1901 and 1917, respectively, the Leiden Physics department had the complex all to itself. Three-quarters of a century later, when laboratories were no longer permitted to be located in the city centre, the Physics department moved to the outskirts of the city and the complex at Steenschuur, after a radical renovation, became the accommodation of the Leiden Law department. At the same time it is also a place of remembrance, stirring memories of four Nobel Prize winners who celebrated their triumphs there, memories of what was once the coldest place on earth.

The coldest place on earth was created by Kamerlingh Onnes on 10 July 1908, when he was the first to liquefy helium at a temperature of just above absolute zero (−273 °C) (Kamerlingh Onnes 1908). This was a milestone in Dutch (and international) physics, as well as the culmination of a programme that Kamerlingh Onnes had unfolded upon his appointment as professor in 1882 and had carried out with a firm hand, with organisational talent, guts, vision, inexhaustible patience and enormous perseverance. In his inaugural speech, in which he launched the motto 'Through measurement to knowledge', Kamerlingh Onnes said that he wanted to test the molecular theories of his colleague and friend Johannes Diderik van der Waals (Laesecke 2002) from Amsterdam. The building, a cryogenic laboratory, a true cold factory, was the obvious consequence of that wish. It was all about putting Dutch physics on the map. In this way nationalism, not unusual in that period, went hand-in-hand with an international focus.

[4] UB Leiden, Archief Curatoren II, inv.nr. 115, bijlage 26, 13 February 1851.

In the last quarter of the nineteenth century this national physics flourished after a period of stagnation (Willink 1998). At the beginning of this period of success, also referred to as the ‘second Golden Age’ (a reference to great seventeenth-century scientists such as Swammerdam, Huygens, Boerhaave and Van Leeuwenhoek), Van der Waals wrote his thesis in 1873 (regarding the equation of the state of a gas, based on the existence of molecules). Forty years later, when Kamerlingh Onnes received the Nobel Prize for Physics for his work in the field of low temperatures (with the highpoint the discovery of superconductivity in 1911, it gives the impression that the prize was received for superconductivity, but it was for helium) (Kamerlingh Onnes 1911; Bruyn Ouboter et al. 2011), his German colleague Waldemar Voigt called his neighbouring country, the Netherlands ‘Ein Grossmacht in der Physik’ (a superpower in physics) (Voigt 1913).

So how can that success be explained? In addition to wider social factors such as increased mobility and economic growth, two specific educational reforms stand out: the introduction of the Dutch High School, *hogere burgerschool* (HBS), in 1863 and the new Higher Education act in 1876 (Berkel 1998).

First of all, the HBS (Mandemakers 1996). This was the brainchild of the liberal Thorbecke, the man of the constitution of 1848. In 1862 as responsible minister he took the initiative for a law on secondary education. At a time in which the country flourished economically and industrialisation had finally got started in the Netherlands, there was a growing need for educated leaders in the areas of technology, trade, industry and administration. Well-educated manufacturers and industrialists were needed, as well as civil servants and office personnel, land surveyors and engineers, heads of banking houses and competent shopkeepers. The elitist gymnasium school, which educated and prepared students for scholarship, did not meet that need, while primary education and the ‘French school’ also failed in this regard to meet this completely. Thorbecke, with the German *Realschule* in mind, wanted a new type of school that would offer a general education aimed at the immediate needs of modern society, and which would have a focus on modern languages and sciences. This tapped into the talent that could be found in the population at large, talent that would otherwise have been unused. The new type of school was an enormous success.

The HBS was expressly not to prepare students for university, but in practice the new school soon developed into a supplier of academic science talents. This was all due to the laboratories for physics and chemistry. These laboratories for young researchers were so advanced that many university laboratories were not even in the same league. Inquisitive students had a taste of real science there—and came to like it. Of the five Dutch scientists who had received a Nobel prize before the First World War (Van ’t Hoff, Lorentz, Zeeman, Van der Waals and Kamerlingh Onnes), four had been to the HBS and the one who had been too old for it (Van der Waals), had been a teacher there. Einthoven and Eijkman (Nobel Prize for medicine in 1924 and 1929, respectively), Bakhuis Roozeboom, Hamburger, Dubois and a list of other prominent (and less prominent) scientists went to the HBS. ‘I believe’, said palaeoanthropologist Eugène Dubois, ‘that if I had been to a gymnasium, much of my scientific aptitude would have been lost’ (Willink 1988, p. 32). HBS students, by the way, prior to being accepted for a science study, had to take an entrance exam in Greek and Latin.

Secondly, the Higher Education Act. Since 1876 the primary task of universities was no longer 'educating students for scholarship', as decreed in the Organic Law of 1815, but 'educating students to be able to carry out science independently and hold social positions for which a scientific education is necessary' The new law made room for the increased specialisation within science, and the emphasis shifted from *Bildung*, from educating a morally high-minded social elite, to a stronger focus on scientific research. Modern scientists no longer were purveyors of culture and educators of the people, but presented themselves as professionals and specialists. Their favourite place was the research front, autonomous in their movements and inaccessible for outsiders.

The new law immediately led to a considerable increase in the number of chairs. Furthermore, the Atheneum Illustre in Amsterdam was promoted to a fully fledged university, with Van der Waals as Professor of Physics. In Leiden the Physics department was split up. In 1877 Hendrik Antoon Lorentz was appointed Professor of Mathematical Physics, alongside Experimental Physics headed by Rijke. Kamerlingh Onnes, who at the time was busy in Groningen, northern Netherlands, finalising his thesis, had hoped to become an unsalaried university lecturer at Leiden and to give lectures on gas theory and thermodynamics. The appointment of Lorentz upset his plans. Not until 1882, after an intermezzo at the Polytechnic in Delft (the precursor of the technical university), did it all turn out all right for Kamerlingh Onnes when he became Rijke's successor in Leiden (Delft 2007a, pp. 139–152).

When Kamerlingh Onnes on 19 September 1882 took over the Leiden Physics Laboratory from Rijke, hardly anything had changed there since its completion in 1859. Upon entering through the side entrance of the north wing, opposite the building of the *Maatschappij tot Nut van 't Algemeen* at Langebrug, one would arrive in a small vestibule with attached staircase (see the plan) (Het Natuurkundig Laboratorium 1904, pp. 11–12). The first floor housed the collection of valuable instruments; in 1879 Rijke proudly mentioned that his old equipment 'still work now just as well as they did when 's Gravesande acquired them 150 years ago' (Rijke 1879, p. 76). The basement stored fuels as well as housing a small workshop. On the left of the vestibule was the professors' room; on the right the scales room. Behind this there were two work rooms that measured 8 × 6 m (intended for students to carry out practical exercises), the twice-the-size classroom and the professor's study (Fig. 17.1).

As soon as Kamerlingh Onnes sized up the situation in his laboratory, he knew that only a rigorous reorganisation could save his research plans. At the time when his predecessor Rijke moved into the Steenschuur when it was completed in 1859, it perhaps then met the requirements of the times. It was now, however, hopelessly outdated. 'The standstill here since that time has, however, been a great step backwards,' maintained the new professor-director to the board of governors regarding his renovation plans on 1 April 1884, 'so much so that the laboratory now lags far behind that of even the Polytechnic School in Delft and the University of Amsterdam.' Kamerlingh Onnes said that if one were to compare this with the situation

Fig. 18.1 Plan of Leiden physics laboratory

abroad, then the only conclusion that could be drawn was that the Steenschuur was in 'a state of decline'.[5]

But Kamerlingh Onnes did not give up and before any of the modifications were carried out to his laboratory he had already started with an internal reorganisation. The first people to find out for themselves that the new professor-director had radically different ideas from his predecessor were the personnel. On 13 November 1882, the Monday after the inaugural lecture, mechanic C.W. Kouw, who until that time was called custos, and amanuensis G. Veere were told that their working hours were set at 10 h per day. What's more, Kouw and assistant Sissingh from that moment on had to record their activities in a logbook.[6] The following Sunday Kamerlingh Onnes went to the governors with a request for a 'special subsidy' of *f* 1724 to acquire Kouw a 'fine' and 'course' lathe and to equip him with 'various equipment and tools'.[7] Such initiatives were commonly saved for when the annual budget was submitted around 1 May, but Kamerlingh Onnes considered his request to be 'of such fundamental importance' that he could not wait for this. At the same time he asked that the amount allocated for 1883 for purchasing and maintaining instruments and tools be increased from *f* 1340–*f* 2500. Only then would the Leiden Physics Cabinet be able to hold onto its current 'modest position' of 'meeting the mediocre requirements of a second-rate university'. The total amount of subsidy remained far behind that for chemistry, whilst the progress made in physics 'in recent times is not inferior to those made in chemistry'. 'It is certainly striking,' wrote Kamerlingh Onnes diplomatically, 'that even with the meticulous management of

[5] HKO to curatoren, 1April 1884, UB Leiden, Archief Curatoren, inv. no. 36.

[6] Museum Boerhaave, archief HKO, inv. no. 260.

[7] HKO to curatoren, 19 November 1882, UB Leiden, Archief Curatoren, inv. no. 1655.

Professor Rijke very important areas of research could no longer be carried out effectively.'

In a memorandum, 'Urgent requirements for Physics education', Kamerlingh Onnes set out his plans—inspired by the physics laboratory of Friederich Kohlrausch, which opened in 1879 in Würzburg.[8] For Medicine students, who took Physics in their first year, a lecture room with 60 seats was needed, as well as a space for practicals and a dark room. Beginner Physics students, too, needed to get a room, which could also be used as a lecture room. Furthermore, a room for practical experiments (with permanent set-ups) was needed and a lecture room for the Professor of Theoretical Physics Lorentz. Kamerlingh Onnes wanted to give more advanced physicists (initially he had in mind two students and a Ph.D. student) each their own small room where they could carry out experiments without being disturbed. For himself he wanted a 'private laboratory' for scientific research as well as a small office. Two rooms were needed for setting up 'precision instruments'; one room for scales, a clock and a barometer; and another 'room for instruments for electrical and magnetic measurements', free from 'iron masses'. Finally, Kamerlingh Onnes needed a workshop, a room for a gas engine, and a space to store Rijke's old collection of physics instruments. The governors were impressed by so much ambition and sent a 'positive advice' to the minister.[9]

The transformation into a research laboratory not only involved a radical renovation, but a great deal of expansion work also had to be carried out. Upon his appointment Kamerlingh Onnes was promised that the Chemistry department, which shared the main building with him, would move elsewhere in the city, but it took until 1917 for the left wing to become available. And so, small, connected buildings along the Langebrug arose as well as temporary sheds in the garden. Like a growth, the laboratory expanded, onto the Langebrug, and into the back garden. Willem Einthoven, who ruled over the nearby physiological laboratory, looked enviously upon the building work, as his neighbour Kamerlingh Onnes slowly expanded his empire. His string galvanometer, a highly sensitive instrument for registering cardiac sounds (electrocardiogram or ECG), was severely disrupted by all the droning pumps at the physics department. Einthoven (who won a Nobel Prize for his work in 1925) demanded drone-free periods. Kamerlingh Onnes considered the complaints about ground vibrations grossly exaggerated, and a major argument broke out between the two men (Delft 2007a, pp. 412–421).

Once the education for 'starters', among whom future physicians, was sorted in 1886, it was then the turn of the 'more advanced students'. There were only a few of these. Advanced students did not do standard experiments but were taught personally by Kamerlingh Onnes to become researchers—he detested giving lectures. With unflagging zeal and great willpower Kamerlingh Onnes pressed governors and the Ministry in The Hague with requests for support, set down in a flood of letters, memorandums, pleas and explanations. Governors sometimes became tired of all that dynamism. When Kamerlingh Onnes asked in December 1886, outside

[8] Museum Boerhaave, archief HKO, inv. no. 260.

[9] Curatoren to Binnenlandse Zaken, 10 April 1884, UB Leiden, Archief Curatoren, inv. no. 36.

the regular budget, for 3200 guilders intended for the purchase of an (already hired) steam machine and for gas and water in the new rooms, the internal reactions were rather irritable. 'Our demanding Professor will cut his coat according to his cloth,' noted one governor. A colleague thought his timing was 'very bad', 'but perhaps he is acting in consultation with the officials of the department and has already persuaded them.'[10]

On the wish list was a third assistant, the purchase of instruments and machines for courses on 'molecular forces' and 'electromagnetic measurements', a warehouse, a custodian and more space. He got it all, even though the investments were considerable and it took a while before the federal ministry forked it out. Kamerlingh Onnes was actually busy creating a cold factory, intended for the scientific research that he had unfolded in his inaugural lecture of 1882. For tactical reasons, however, he kept this activity *low profile* and when he visited the governors and ministry he talked a lot of hot air about the necessity of good education. Courses on 'molecular physics' and 'electromagnetic measurements' for the more advanced students were mainly thought up to facilitate the construction of a cryogenic laboratory. By explicitly and continuously stressing education, Kamerlingh Onnes managed to get the money he needed for his cold factory from the government. Even in 1924, when the Rockefeller Foundation offered $ 100,000 to buy instruments and in return demanded an annual amount of *f* 10,000 in *matching* funds from the Dutch government for additional researchers to be able to benefit from those instruments, it was necessary to meticulously set matters down in an agreement—that is how focused on education people were in The Hague then, too (Delft 2007a, pp. 583–592).

A laboratory that from an educational point of view had to meet so many requirements was bound to be expensive. 'It is astounding,' said Kamerlingh Onnes in 1889 in a plea to the minister, 'that the importance of the study of molecular forces should be questioned in the country that has a Van der Waals.' No money, then no course in this area, nor one in 'electromagnetic measurements'.[11] The minister neatly processed everything in his response and the House of Representatives agreed. Kamerlingh Onnes got his third assistant, a warehouse (2000 guilders worth of red copper rods were bought, along with zinc wire, ebonite bars, steel, caoutchouc stoppers, glass, household goods and chemicals)[12] and a series of tools for artificial cold inside. He also had 3000to buy various other things, and another 5,000 guilders in the future. Previously the laboratory had already been provided with an electrical set-up for approximately 5,000 guilders.[13] The installation could be called 'considerable in every respect', with a modern control desk, a Siemens dynamo (which supplied 70 A at 75 V) and 31 accumulators (*De Ingenieur*, 28 maart 1891). Kamerlingh Onnes was finally able to carry out his scientific programme, together with his students. He had every reason to be satisfied, but was careful to express his satisfaction publicly. Now, putting governors under pressure—that worked.

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[10] HKO to curatoren, 10 December 1886, UB Leiden, Archief Curatoren, inv. no. 48.

[11] HKO to Binnenlandse Zaken, 3 November 1889, archief Huygenslaboratorium.

[12] UB Leiden, Archief Curatoren, begroting natuurkunde 1890.

[13] Archief Huygenslaboratorium, file 'electrische installatie'.

In a period of 10 years Kamerlingh Onnes managed to change a sleepy Physics Cabinet into a dynamic laboratory with unique facilities, where the doctorates followed one another in rapid succession and which was on the threshold of a series of important discoveries. Governors, who came to have a look in May 1891, were satisfied. ‘We got the impression’, it read in the report, ‘that in this establishment science is subservient to education in a most excellent manner.’ During the guided tour the governors became very impressed by the manner in which Kamerlingh Onnes involved his students in the scientific research. The realisation also dawned that work at the *ketelhuis* really could no longer continue, and that new work areas were desperately needed. ‘Mr Kamerlingh Onnes admitted,’ the governors said in their report, ‘that he is an expensive professor, but stressed that this was not his fault.’ Instruments were expensive and physics experiments required a ‘large space’. Meanwhile, Leiden University had Lorentz and Kamerlingh Onnes, two ‘gifted men, […] men who possessed an organisational talent to delegate the work to assistants and students, whilst they themselves are the souls of the movement. […] They urgently require more vigorous support. Time is running away.’[14]

It will now be clear that Kamerlingh Onnes was a man that played a crucial role in the flourishing period that started at the Leiden Physics department at the end of the nineteenth century (Delft 2007a). Heike Kamerlingh Onnes, born in 1853 in Groningen, was the eldest son of a brickworks owner. Like his father, Heike had weak lungs and enjoyed hard work. And he, too, was a manufacturer, not of roof tiles, but of cold. His entrepreneurial talent came in handy in Leiden. Building a cryogenic laboratory (*kryos*, Greek for cold) of international substance, of a size and with a workforce that were not equalled anywhere in the world, required more than the talents of a good physicist. Anyone at the Steenschuur who saw the jumble of tubes, taps, gas cylinders, gas tanks, liquefaction stations, bare bottles, cryostats, workshops, instruments and equipment for scientific research as well as the noisy pumps and droning engines, could easily imagine himself in a factory. But this was a cold factory, with Kamerlingh Onnes as the professor-director who maintained a strict rule and set the course with a firm hand. A man who set up a well-oiled organisation consisting of a custodian (manager), scientific staff, a manager, instrument makers, glass-blowers, laboratory assistants, technicians, a machinist and a custos. And not to forget an army of ‘boys in blue’, apprentice instrument makers, wearing blue overalls, who internally received a multifaceted education, carried out numerous odd jobs at the laboratory and followed compulsory theory lessons in the evenings. In fact, Kamerlingh Onnes introduced what was later to be known as *Big Science*. With his orchestrated approach of research where people did not work individually but carried out joint efforts on well-defined goals, Kamerlingh Onnes set an example that was followed by other laboratories (Delft 2008).

This Big Science approach, unique worldwide in its combination of large scale and focus, could only succeed with someone with perseverance, guts, willpower, vision and inexhaustible patience. Someone who managed with a firm hand, but at the same time had the ability to captivate and persuade people to commit themselves to

[14] UB Leiden, Archief Curatoren, inv. no. 71, doc. 448, 8 May 1891.

him. Someone who knew as no other the art of manipulating the authorities—Kamerlingh Onnes always believed that the 'destruction' of what had been achieved at the Steenschuur throughout the years was an ever-present threat—for as long as it would take for them to give their 'expensive professor' the space and equipment he needed in order to realise his aims. Someone who found it easy to establish contacts both in the world of physics and far beyond, had a good eye for people who could help him further, pampered his guests and who was far too shrewd to allow arguments or feuds that could damage him. In short, Kamerlingh Onnes brimmed with organisational talent and social instinct—capacities that he had displayed as rector of Vindicat Atque Polit, the Groningen student fraternity, and without which his mission in Leiden would not have stood a chance. Kamerlingh Onnes was a very good scientist, but he attributed his success with the cryogenic laboratory to his organisational talent, social skills and his constant focus on cold.

What's more, Kamerlingh Onnes was exceptionally creative in the way he created win-win situations. A good example is the way in which he managed to win over the Amsterdam tobacco dealer and philanthropist Pieter Wilhelm Janssen to his cause from 1897 onwards (Delft 2011). A students' system for instrument making, closely tied to the Physics Laboratory, was a blessing for Leiden's Physics department. On top of this, it produced well-educated graduates who were much in demand both in the Netherlands and abroad. In 1901 the instrument maker's school was set up with the financial support of Janssen. By allowing his important technicians to teach at the school, he was able to pay them extra on top of their state salaries. In this way, he safeguarded them from being bought off by industry. Also with the support of Janssen, Kamerlingh Onnes was able to appoint additional research assistants as well as provide perks to crucial people at the laboratory in order to keep them with him—everything with the brilliant argument that those extra researchers (that the government did not want to appoint) used extra instruments and equipment, which would in turn have a positive effect on the apprentice instrument-maker course. Socially responsible activities while at the same time carrying out pure scientific physics research—it all happened in Leiden.

It took about 12 years of tinkering before Kamerlingh Onnes managed to get his installation for liquid oxygen running as required. It was only then that the research into the molecular theories of Van der Waals could really start (Helden 1989; Gavroglu and Goudaroulis 1991). In addition, there was the Lorentz series: experiments into the influence of magnetism on light. The theoretician Lorentz received his doctorate on the subject, and when Kamerlingh Onnes started in Leiden in 1882 he immediately offered 'Hentje', who he knew from his HBS years, space in which to carry out experiments. Lorentz started off enthusiastically but gave up his research after a few months. Kamerlingh Onnes' delicate lungs began to give him problems—he had chronic bronchitis and had to recuperate abroad. Lorentz permanently took over the physics classes for the first year students (mainly medical students), including practical classes, from Kamerlingh Onnes. This favour cost Lorentz, whose star was rising, 10–15 h per week. A group of assistants took over the research, after which they received their doctorates through Kamerlingh Onnes with theses bearing titles that invariably began with 'Measurements'. Articles were published in the journal of the Kamerlingh Onnes laboratory: *Communications from* *the Physical Laboratory of the University of Leiden*. The fact that when the journal first started in 1884 it was decided to publish it in English, and not in German, which would have been the more obvious choice of language at the time, showed a great deal of foresight.

The highpoint of the Lorentz series was the discovery of the Zeeman effect in the summer of 1896 (Arabatzis 1992). Lorentz, who within just a few days came up with the theoretical explanation for the effect of a magnetic field on light, and Zeeman were both awarded the Nobel Prize for Physics for this work in 1902. Kamerlingh Onnes, who was initially annoyed by his assistant daring to deviate from the agreed measurement programme in the absence of his boss (on holiday in the Alps), quickly forgave Zeeman for his audacity. When Zeeman in the autumn of 1896 was offered the position of lector in Amsterdam, Kamerlingh Onnes paid a personal visit to the Minister to try to squeeze out some money for a similar position in Leiden, so that Zeeman could stay *and* Lorentz could be relieved of his educational duties. He left The Hague empty-handed, however, and Zeeman spent the rest of his career in Amsterdam. It was only in 1905 that reinforcements came to relieve Lorentz. When there was a threat of Lorentz going to Munich, Leiden University pleaded to the government for help, which resulted in the university being able to appoint, in addition to Kamerlingh Onnes, a second professor of experimental physics who was able to relieve Lorentz from his educational duties (Delft 2007a, p. 208).

A quarter of a century later Kamerlingh Onnes managed to build a cryogenic installation of international standing. When it came to 'equipment subsidy', Leiden had more to spend than Utrecht and Groningen together. After the success with liquid helium in 1908, this lead increased even more, and in the early 1920s the physics department of Leiden received more than the combined total for Utrecht, Groningen *and* the University of Amsterdam. In the meantime, Leiden carried out mainly measurement programmes; it was not the intention to 'just try something out'. Kamerlingh Onnes gave his people excellent training, but it was in 'through measurement to knowledge' physics. For Kamerlingh Onnes the difficulty in experimentation lay in 'keeping on course amidst all the provoking questions'. It was only at the end of his career, when the Leiden monopoly on liquid helium was broken and foreign competition emerged, that he became somewhat more flexible regarding tentative explorations and side roads.

This emphasis on *planfysica* (conducting physics experiments guided by well defined goals) is very easy to explain. During the early years of the cryogenic laboratory, liquid oxygen was not available every day and the researcher who had to pour that blue fluid into his cryostat probably would have wondered what he was going to do it that day. The same applied to helium, but to an even greater extent: in the academic year 1922/1923 there were 18 'helium days'. Just as Kamerlingh Onnes who due to his weak physical constitution did not like to waste his energy, he did not allow a single drop of helium to be wasted by 'just trying something out.' This resulted in very tightly regimented measurement days that did not allow for any sudden brainwaves or other mischief. It was for this reason that in Leiden in 1923, when a research student from Harvard in Leiden ignored an interesting dip in a graph, the discovery of the phenomenon of superfluity was missed (Gavroglu and Goudaroulis 1988; Dana and Kamerlingh Onnes 1926a, b; Dana 1985).

After the construction of installations for liquid hydrogen (1906) and helium (1908), Leiden increasingly developed into an international facility for physicists wanting to continue their research into low temperature but who did not have the necessary facilities in their own country (Delft 2007b). Particularly the first International Congress on cold held in Paris in 1908, where Kamerlingh Onnes stole the show with liquid helium, unleashed a flood of guest researchers (and visitors) to Leiden. The result was not only a greater diversity in the low temperature work carried out in Leiden, but also a glaring lack of research space. Kamerlingh Onnes did his utmost for his foreign guests and hospitably offered them accommodation at his house 'Huize ter Wetering'. This invasion, however, also led to fragmentation and the genuine Leiden research of his students came under pressure.

Kamerlingh Onnes had good contacts everywhere, both inside and outside the University. In 1882, during the squabbling concerning his appointment in Leiden (his predecessor Rijke had his mind set on appointing Röntgen), he managed to find support from 'influential friends', including Johannes Bosscha (principal of the Polytechnic School in Delft). Contacts in the Navy loaned him compressors from submarines (used to launch torpedoes); he acquired coils of Rühmkorff (electromagnetic induction) from the Delft artillery depots (used to generate high voltage); the cannon foundry in The Hague supplied an hydraulic pump with a capacity of 250 atmospheres; and the construction workshops of the Delft artillery helped him with grinding cutters and assembling an electromagnet. He also had good contacts with the Philips company, which in 1914 started up its own research laboratory with student Gilles Holst as its first director (Boersma 2002). Materials were loaned back and forth and various data was exchanged—both laboratories, Leiden and Eindhoven, were very interested in noble gases. For his part Kamerlingh Onnes made his standard mercury manometer available to calibrate the manometers of government departments and other institutes.

Contacts matter. In the aftermath of the explosion issue of 1895 (the Leiden Physical Laboratory used explosive substances like ethylene on the very spot where in 1807 a gunpowder ship had exploded), the Leiden Board of governors wanted Kamerlingh Onnes out of the city. The tense situation slowly evaporated, however, when in 1899 first Bosscha and then Van der Waals joined the board. Kamerlingh Onnes was a member of the Comité Scientifique of the Solvay Institute (his friendship with the Brussels soda manufacturer didn't do him any harm) and he was assistant director of the Association Internationale du Froid. In this latter organisation, which was set up in 1909 to further advance applied cryogenics, Kamerlingh Onnes managed to make *la science pure*, too, come into its own by referring to the thousands of hectolitres of liquid air that had been produced since Cailletet's mist of 1877. Positions such as these gave him international prestige as *monsieur zéro absolu*, and resulted in funds for the cryogenic laboratory. More than 30 foreigners (a third of whom were professors) came to Leiden for cryogenic research,[15] and many

[15] Researchers from abroad: A.W. Gray, L.I Dana, G. Breit (USA); J.E. Verschaffelt, Ch. Nicaise, J. Timmermans (Belgium); A.L. Clark (Canada); S. Weber (Denmark); E. Cohn, M. Reinga-

of whom called in at the Steenschuur to see the cryogenic installations with their own eyes. His international orientation lead to Kamerlingh Onnes officially protesting, as did Lorentz, against the isolation of German and Austrian fellow scientists after the First World War. The fact that he managed to be tactful in his efforts to restore contacts with the Central Powers can be seen from his election in 1920 (when emotions regarding this subject were running high) as a *membre correspondance* of the Académie Française (Delft 2007a, p. 549).

Kamerlingh Onnes was not unfamiliar with opportunism. When he spoke in London he adulated Faraday, in Paris he named the cold pioneers Cailletet and Claude and in his own country he praised Van Marum. But Kamerlingh Onnes had one foe: Einthoven, his neighbour from the Physiology department who, due to the sensitivity of his string galvanometer, complained about the ground vibrations coming from the cryogenic laboratory and had claimed land that Kamlerlingh had intended for his expansion drive for physics. In this battle between the two, Kamerlingh Onnes did not give an inch. If he had to, he could be very unpleasant—and continue to be so for years.

Kamerlingh Onnes' gift for getting people, both high and low, on his side played a major role in his success. 'He was a brilliant man,' wrote Pieter Zeeman in 1926 in an obituary for his deceased boss. 'He governed the minds of his staff, like the wind driving the clouds. With a flattering comment, or through amusing, and occasionally also sharp mockery he was able to work miracles. Even those who were above him on the hierarchical ladder fell under his charm […] and at a last moment sometimes a decision could be turned to work in Kamerlingh Onnes' favour (Zeeman 1926).

After Kamerlingh Onnes' departure in 1923, Leiden retained for some time its leading position in low-temperature research, but the international competition quickly caught up. What didn't help advance the Physics Laboratory—which was renamed the Kamerlingh Onnes Laboratory in 1932—was it being split into two departments in 1924. Not one but two directors had to defend Leiden's leading position. Department 1 was headed by the strait-laced and dour Willem Keesom (a lesser version of Kamerlingh Onnes) and focused on thermodynamic research at low temperatures. It also housed the cryogenic laboratory. Department 2, under the management of the capricious and intuitive Wander de Haas, carried out research on electricity and magnetism. Fragmentation is never a good recipe for efficient operations. On top of this, these two men had very different characters and did not get on well with one another (Casimir 1983).

Nevertheless there were some successes. In 1927 Keesom was the first to freeze liquid helium, and in the early 1930s De Haas managed to break various cold records using the recently delivered large electromagnet (designed and ordered by Kamerlingh Onnes) (Maas 2006). But as soon as laboratories in Oxford, Cambridge,

num, W. Heuse, H. Happel, W.E. Pauli, P. Lenard (Germany); H.H.F Hyndman, J.P. Dalton, T. Verschoyle, L.C. Jackson, J.C. Swallow (Great Britain); M. Boudin, J. Becquerel, H. Becquerel, E. Mathias, Marie Curie (France); L. Vegard (Norway); F. Hasenöhrl (Austria); C. Zakrzewski, M. Wolfke (Poland); J. Palacois Martinez (Spain); B. Beckman, Miss. A. Beckman (Sweden); P. Weiss, A. Perrier, K. Hof (Switzerland).

Moscow, Berlin and elsewhere also had access to liquid helium, Leiden was often just one step behind in the truly large discoveries. Whilst there was some degree of preconceptions in Leiden, researchers in cold laboratories in other countries had a fresh outlook on the subject. The Leiden technicians were highly capable and skilled in making instruments, but all too quickly labelled any innovative and wild ideas of newcomers as ‘crazy’. And lastly, what did not help at all was that the successor of Keesom and De Haas—as of 1948 the Kamerlingh Onnes Laboratory once again had one director—did not create a climate in which talent could flourish. A number of times Cornelis Gorter, who obtained his doctorate in 1932 with De Haas and was a brilliant experimental scientist, was close to a pioneering discovery (Waals 1996), but Nico Bloembergen (Nobel Prize 1981), an at least equally brilliant mind, was given little freedom as a research student under Gorter and left for good to Harvard in 1948.

The construction of the Huygens laboratory in the early 1970s, and the relocation of part of Leiden University’s Physics department (molecular physics and quantum optics) from the city centre resulted in more space again. Twenty-five years later the rest followed, and Leiden’s Physics department was again united. These days there is an intensive collaboration with the Delft University of Technology with the joint ambition of building a working quantum computer. If the partners succeed in being the first to build such a wonder machine, using stable Majorana particles (made in Delft) and smart theoretical concepts (conceived in Leiden), this achievement will immediately be compared with the construction of the first helium liquefactor in 1908. But before we reach that stage the university’s new science location, with which we started this story, will undoubtedly be completed—for a price many times the amount of 115,767 guilders from yesteryear. History repeats itself, but not at the same price.

References

Arabatzis, Theodore. 1992. The discovery of the Zeeman effect: A case study of the interplay between theory and experiment. *Studies in History and Philosophy of Science* 23:365–388.

Berkel, K. van. 1998. *Citaten uit het boek der natuur; opstellen over Nederlandse wetenschapsgeschiedenis*. Amsterdam: Bert Bakker.

Boersma, K. 2002. *Inventing structures for industrial research. A history of Philips NatLab 1914–1946. NEHA-series III*. Amsterdam: Aksant Academic Publishers.

Bruyn Ouboter, Rudolph de, Dirk van Delft, and Peter H. Kes. 2011. The discovery and early history of superconductivity. In *100 years of superconductivity,* eds. Horst Rogalla and Peter H. Kes, 1–28. London: CRC Press, Taylor and Francis Group.

Casimir, H. B. G. 1983. *Haphazard reality: Half a century of science*. New York: Harper & Row.

Clercq, Peter de. 1997. *At the sign of the oriental lamp: The Musschenbroek workshop in Leiden 1660–1750*. Rotterdam: Erasmus.

Dana, Leo. 1985. My experience at the University of Leiden, Holland, low temperature research laboratory, September, 1922 through July, 1923. In *Cryogenic science and technology: Contributions by Leo I. Dana,* eds. Russell J. Donnelly and Arthur W. Francis, 14–32. New York: Union Carbide Corp.

Dana, L. I., and H. Kamerlingh Onnes. 1926a. Further experiments with liquid helium. B.A. Preliminary determinations of the latent heat of vaporization of liquid helium. KNAW, Proceedings, 29 II: 1051–1060. Amsterdam: KNAW (Koninklijke Nederlandse Akademie van Wetenschappen, Royal Dutch Academy of Sciences). Communications 179c. (English translations of the proceedings were published by Kamerlingh Onnes as Communications from the Physical Laboratory of the University of Leiden).

Dana, L. I., and H. Kamerlingh Onnes. 1926b. Further experiments with liquid helium. B. B. Preliminary determinations of the specific heat of liquid helium. In KNAW, Proceedings, 29 II, 1926: 1061–1068. Amsterdam: KNAW. Communications 179d.

Delft, Dirk van. 2007a. *Freezing physics; Heike Kamerlingh Onnes and the quest for cold*. Amsterdam: Edita KNAW.

Delft, Dirk van. 2007b. Facilitating Leiden's cold: The International Association of Refrigeration and the Internationalisation of Heike Kamerlingh Onnes's cryogenic laboratory. *Centaurus* 49:227–245.

Delft, Dirk van. 2008. Little cup of helium, big science. *Physics Today* 61:36–43.

Delft, Dirk van. 2011. Een tweesnijdend zwaard. Het Janssenfonds voor vakopleidingbeurzen en het ontstaan van de Leidse instrumentmakersschool. Drieëntwintigste Jaarboek der sociale en economische geschiedenis van Leiden en omstreken, 167–202. Leiden: Dirk van Eck-Stichting.

Gavroglu K., and Y. Goudaroulis. 1988. Kamerlingh Onnes' researches at Leiden and their methodological implications. *Studies in the History and Philosophy of Science* 19:243–273.

Gavroglu, Kostas, and Yorgos Goudaroulis. 1991. *Through measurement to knowledge. The selected papers of Heike Kamerlingh Onnes 1853–1926*. Dordrecht: Kluwer Academic Publishers.

Gedenkboek. 1904. *Het Natuurkundig Laboratorium der Rijks-Universiteit te Leiden in de Jaren 1882–1904*. Leiden: IJdo.

Helden, Anne C. van. 1989. *The coldest spot on earth*. Leiden: Museum Boerhaave.

Jorissen, W. P. 1909. *Het chemisch (thans anorganisch chemisch) laboratorium der universiteit te Leiden van 1859–1909*. Leiden: Sijthoff.

Kamerlingh Onnes, H. 1908. The liquefaction of helium. Koninklijke Nederlandse Akademie van Wetenschappen (Royal Dutch Academy of Sciences). Proceedings 11:168–185. Amsterdam: KNAW. Communications 108.

Kamerlingh Onnes, H. 1911. Further experiments with liquid helium. C. On the change of electric resistance of pure metals at very low temperatures, etc. IV. The resistance of pure mercury at helium temperatures. Koninklijke Nederlandse Akademie van Wetenschappen (Royal Dutch Academy of Sciences), Proceedings 13:1274–1276. Amsterdam: KNAW. Communications 120b.

Laesecke, Arno. 2002. Through measurement to knowledge: The inaugural lecture of Heike Kamerlingh Onnes (1882). *Journal of Research of the National Institute of Standards and Technology* 107:261–277.

Leidsche Studenten-Almanak 1860. Leiden: Hazenberg.

Maas, Ad. 2006. Koud zout. Leidse kouderecords in de jaren dertig. *Nederlands Tijdschrift voor Natuurkunde* 72:264–267.

Maas, Ad. 2012. The man who erased himself. Willem Jacob 's Gravesande and the enlightenment. In *Newton and the Netherlands. How Isaac Newton was fashioned in the Dutch Republic,* eds. Jorinck Eric and Ad Maas, 113–137. Leiden: Leiden University Press.

Mandemakers, Cees. 1996. Gymnasiaal en middelbaar onderwijs. Ontwikkeling, structuur, sociale achtergrond en schoolprestaties in Nederland, ca. 1800–1968. Rotterdam: Erasmus.

Otterspeer, W. 1992. De wiekslag van hun geest. De Leidse universiteit in de negentiende eeuw. Den Haag: Hollandse Historische Reeks.

Rijke, P. L. 1879. Levensschets van Willem Jacob's Gravesande. *Album der Natuur* 28:65–88. Haarlem: A.C. Kruseman.

Voigt, Waldemar. 11 December 1913. *Chemiker Zeitung* 1518–1520.

Waals, J. H. van der. 1996. Gorter's footprints on the trail that led to magnetic resonance. *Encyclopedia of Nuclear Magnetic Resonance* 1:677–680.

Wiesenfeldt, Gerhard. 2002. *Leerer Raum in Minervas Haus. Experimentelle Naturlehre an der Universität Leiden, 1675–1715*. Amsterdam: Edita/KNAW.

Willink, Bastiaan. 1988. *Burgerlijk sciëntisme en wetenschappelijk toponderzoek. Sociale grondslagen van nationale bloeiperioden in de negentiende-eeuwse bètawetenschappen*. Rotterdam: Erasmus.

Willink, Bastiaan. 1998. *De tweede Gouden Eeuw: Nederland en de Nobelprijzen voor natuurwetenschappen, 1870–1940*. Amsterdam: Bert Bakker.

Zeeman, P. 1926. Prof. Dr. H. Kamerlingh Onnes †. *Algemeen Handelsblad* 22 Febraury 1926.

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Chapter 19
A Peripheral Centre. Early Quantum Physics at Cambridge

Jaume Navarro

In a letter to Niels Bohr at the end of the Great War, the Cambridge physicist Charles Galton Darwin complained "that physics and applied mathematics here [in Cambridge] are in an awful state (…) There are plenty of very intelligent people, only under the blighting influence of studying such things as strains in the ether" and paying scant attention to the theory of the quanta. Particularly critical was he of the outgoing director of the Cavendish laboratory, Joseph John Thomson, "who seems to disregard everything that has been done since about 1900."[1] Just over a decade later, the perception about Cambridge physics worldwide had radically changed. In an oft-quoted letter to Ernst Rutherford in 1932, Bohr wrote: "perhaps more than ever I wish in these days that I was not so far away from you and the Cavendish laboratory."[2] Certainly, Darwin's complaint emphasized what he regarded as the poverty of theoretical physics in Cambridge, while Bohr's enthusiasm related to the experimental results in the so-called *annus mirabilis* of the Cavendish (Hughes 2000). In any case, the two letters set the stage for the problem I want to discuss in this paper: the place of Cambridge physics in the early years of the theory of the quanta, a place that can be regarded as partly peripheral.

Let me clarify, from the outset, what I mean by Cambridge being in the periphery of mainstream theoretical physics in the period 1905–1925.[3] Indeed, both the University and the Cavendish laboratory were central foci of early twentieth-century science, physics included. Joseph John Thomson was the head-figure of a school of physics in the Cavendish that attracted dozens of graduate students and researchers every year from all over the British Empire and beyond. The 1906 Nobel Prize for his long career on electric discharges in tubes and his presidency of the 1909 British Association for the Advancement of Science (BAAS) are but two of the many

[1] Archive for the History of Quantum Physics, Darwin to Bohr, 30.05.1919, microfilm BSC 1, 4.

[2] Archive for the History of Quantum Physics, Bohr to Rutherford, 2.05.1932, microfilm BSC 1, 4.

[3] For discussions on the centre-periphery historiography see Gavroglu et al. (2008).

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honors he received at the beginning of the century in recognition of his work and influence in physics. So, one cannot say lightly that Thomson and his school were peripheral: people came and went to the Cavendish to train and to spread a particular way of doing physics; one that was characterized by a somewhat laissez-faire attitude that promoted individual—rather than collective—work, a flexible approach to experimental precision, and a notion of theoretical physics that was direct heir to the long tradition of the Cambridge Mathematical Tripos—henceforth, MT (Kim 2002). It is the latter aspect that is most relevant to this discussion.

In *Masters of Theory*, the historian Andrew Warwick described the pedagogical régimes in Cambridge that mass-produced an army of mathematicians (*wranglers* who gain first-class honours) who shaped British theoretical physics and mathematics all throughout the nineteenth century and well into the twentieth (Warwick 2003a). His study gave a new insight into the reasons why British physicists were slow in appreciating the novelty and radicalism of Albert Einstein's theory of special relativity, not so much rejecting it but understanding it only in terms of their own traditional (classical) physics of electromagnetism. While the answer Warwick gave was specific to the Cambridge tradition, not so the question. Indeed, relativity was basically a one-man work, an outsider not just to the British milieu but also to the wider scientific world. Thus, the question of why it was Einstein who formulated the relativity theories, and not a British physicist, cannot be attributed to local or national research strategies.

The case of quantum physics is totally different, for this was the collective product of a large network of physicists and mathematicians in some parts of Central Europe, mainly Germany and Denmark. Ever since the early 1970s, with the much-commented Forman thesis, historians have struggled to find context-based explanations for the emergence of a new way of doing physics that would revolutionize physics (Forman 1971; Kojevnikov et al. 2011). The question that has seldom been addressed directly is how and why it was that the early decades of quantum theory almost completely eluded the main centers of British physics, not least Cambridge. Only in the epilogue to the aforementioned *Masters of Theory* does Warwick shift his attention to this problem, suggesting that it was Paul Dirac's particular training in Birmingham, not in Cambridge, as an engineer and not as a mathematician or theoretical physicist, which were the determinants to his becoming the first British actor in the front row of quantum developments in the late 1920s.

In this paper I focus on the ways a number of Cambridge physicists prior to Dirac addressed the emerging quantum theory, so as to shed more light on the extent to which the old university became peripheral to the new physics. Indeed, as Darwin pointed out in his letter to Bohr, before the Great War hardly anyone in Cambridge paid attention to the theory of the quanta. People like Thomson, Joseph Larmor, the Lucasian professor, and a few others referred to the quantum theory only to dismiss it or reject it. As we shall see in section one, when James Jeans, one of the few Cambridge converts to the new physics of radiation, reported on the theory of the quantum to the 1913 BAAS, he was met with a mixture of skepticism and disbelief. He himself was clearly at a loss when it came to justifying the meaning of the theory. In the early 1920s, some, Darwin included, did engage with the new theory, but they did not contribute to it in any major way, partly due to the non-cooperative way of mathematical physics in the Cambridge tradition, partly due to the absence of a strong experimental program in the Cavendish on quantum-related matters, and partly due to the need to understand physics in terms of visual and dynamical models. In Sect. 2 , we shall discuss three members of what I call *the last generation of wranglers*, and their early engagement with the theory of quanta: the aforementioned Darwin, Ralph Howard Fowler and George Paget Thomson. Finally, in Sect. 3, I shall explore the ways in which the quantum was introduced into the Cambridge syllabus, with special mention to a rather unknown character, George Birtwistle, whose approach prevented some students from fully realizing and embracing the radical novelty of the new theory. With all these limitations, however, Cambridge did not disappear for good from the mainstream of theoretical physics. By the early 1930s, with Dirac, it soon regained its centrality, the one it had had throughout the nineteenth century, abandoning its temporal peripheral status.

19.1 Enter the Quantum into the British Isles: James Jeans and His Report

The first written reference to Max Planck's 1900 quantum hypothesis in Britain was probably Joseph Larmor's explicit rejection at the BAAS meeting in Belfast in 1902. In the following years, the general attitude in Britain ranged from total opposition to oblivion but was, more generally, one of scepticism. Ten years later, however, and after the first Solvay Conference in 1911, the increasing presence of Planck's hypothesis in the scientific literature forced a discussion on the topic in the same forum: the BAAS meeting, in Birmingham, in the summer of 1913. James Jeans, who had recently converted to the theory of the quantum and was one of only two British physicists present at the Solvay meeting (the other being New Zealand-born Ernest Rutherford), took on the task of explaining and defending the theory of the quanta to a reluctant audience.

Jeans had been second wrangler in 1898, after which he was appointed fellow and lecturer in Trinity College (Milne 1952). He worked on radiation theory and statistical mechanics, producing his first book, *The Dynamical Theory of Gases* (Jeans 1904) and contributing to what we now know as the Rayleigh-Jeans law for the distribution of the radiation from a black body, which was derived using the equipartition of energy. His constant failure to describe the experimental energy distribution of black-body radiation using classical arguments did not force Jeans, at first, to accept Planck's hypothesis, but to search for alternative mechanisms to explain the experimental law. But by 1910 he had changed his mind, forced by the empirical success of Planck's law as well as by the theoretical proof that this law could be obtained *only* with the assumption of quanta (Hudson 1989). That is why he was happy to attend the significant 1911 Solvay Conference (which neither J.J. Thomson nor Joseph Larmor attended) that set in motion the foundations of quantum theory and to be the herald of the new theory in Britain.

The *Report on Radiation and the Quantum Theory* that Jeans prepared for the 1913 BAAS meeting, and which was published a few months later, acted as the main source from which many British scientists learnt the basic tenets of the quantum theory during the First World War, and immediately afterwards (Jeans 1914).[4] This book is also an open window into Jeans' own *conversion* process, emphasising the impossibility of accounting for black-body radiation with any other hypothesis than Planck's quanta. Einstein's explanation of the photoelectric effect, and the theory of the specific heats of solids by Einstein, Debye and Lindemann are also present, but only as indirect support to the quantum hypothesis.

The *Report* is an interesting exercise in rhetoric to convince British mathematical physicists, mostly influenced by the MT Cambridge tradition, of the unavoidability of the quantum hypothesis. The tendency in Britain at the time was to follow in Joseph Larmor's footsteps; he was still trying to obtain Planck's law in terms of some continuous motion or mechanism, in spite of Jeans' (and also Henri Poincare's) demonstration of the fundamental impossibility of such a project (Hudson 1989, p. 72). For instance, Professor Augustus E.H. Love, second wrangler in 1885 and Sedleian Professor of Natural Philosophy at Oxford since 1898, argued that "from a mathematical point of view there must be infinitely many formulae which would agree equally well with the experiments" (Anonymous 1914, p. 384). The discussions at the Birmingham BAAS meeting "made it abundantly clear that the quantum theory is far from being regarded as inevitable yet by many of the English school of physicists" (Jeans 1914, p. 23). Incidentally, the Birmingham meeting started with a presidential address given by Oliver Lodge on "Continuity", a manifesto in favour of the real existence of the ether, its essentially continuous nature, and against the theories of relativity and quanta (Anonymous 1914, pp. 3–42).[5]

After the account of the mathematical reasons for his own conversion to the theory of the quantum in black-body radiation, Chaps. 3–6 of the *Report* gave a very clear account of the theory's success in explaining radiation, spectra, the photoelectric effect, and the specific heat of solids, leaving for the last chapter what he calls the "physical difficulties" or the "physical basis" of the theory (Jeans 1914, p. 33, p. 79). This is the chapter where we find Jeans trying to understand or, better, to speculate on the physical implications of accepting the quantum theory. Because, from his point of view, the validity of Planck's hypothesis was helpless to explain the physical processes:

> The indications are that there is, underlying the most minute processes of nature, a system of mechanical laws different from the classical laws, expressible by equations in which probably the quantum-constant *h* plays a prominent part. But these general equations remain unknown, and at most all that has been discovered is the main outline of the nature of these equations when applied to isochronous vibrations. (Jeans 1914, p. 79)

The main problem was, for Jeans, not that the quantum theory was, so far, limited in its applicability, but that "even if the complete set of equations were known, it might

[4] For the impact of this *Report* see Milne (1952), p. 17; and McCrea (1985), p. 58.

[5] Lodge's Presidential Address is also a manifesto in defence of spiritualism, psychic research, and a certain unity of Nature with the Creator.

be no easy task to *give a physical interpretation of them, or to imagine the mechanism* from which they originate" (Jeans 1914, p. 79, my emphasis). I emphasise the last sentence because, for him, as for most physicists of the Cambridge school, intelligibility involved the possibility of imagining a mechanism that could account for the observed phenomena. But when faced with the quantum, any "attempt to imagine a universe in which action is atomic leads the mind into a state of hopeless confusion" (Jeans 1914, pp. 79–80).

This last chapter finished with a discussion on the reality of the ether, acknowledging that, in this respect, Continental and British physicists played on different—opposed—sides. Jeans seemed to cling to the reality of the ether, but he relegated it to a second place: the real stumbling block being the contradiction between discrete and continuous theories, both valid for different radiation phenomena. And, with this, the last pages of the book convey a certain amount of pessimism as for the *status quo* of physics. In a free translation from Poincaré's *Dernière Pensées* he wrote:

> It is impossible at present to predict the final issue. Will some entirely different solution be found? Or will the advocates of the new theory succeed in removing the obstacles which prevent us accepting it without reserve? Is discontinuity destined to reign over the physical universe, and will its triumph be final? Or will it finally be recognised that this discontinuity is only apparent, and a disguise for a series of continuous processes? … Any attempt at present to give a judgement on these questions would be a waste of paper and ink. (Jeans 1914, p. 90)

Whereas Chaps. 2–6 of the *Report* were an active exercise in convincing the reader of the inevitability of the quantum hypothesis and its successes, these last pages bring that optimism back to earth by pointing at the difficulties of interpretation of the quantum theory. But this was done in a particular way: these last sentences can be interpreted as a way to encourage British physicists to embrace the theory without *à priori* rejecting it on the grounds that it was not 'physical', i.e., mechanical. Furthermore, the fact that these considerations appear only at the end of the book, as a separate chapter, may indicate that, from Jeans' point of view, one could and should accept the quantum theory without having a full answer to its ultimate physical meaning. Partly following the problem-solving tradition of the Cambridge MT pedagogy, Jeans was more concerned about proving that the quantum theory solved specific problems rather than attempting an overall challenge on metaphysical grounds.

19.2 Wranglers of the Last Generation: Darwin, Fowler and G.P. Thomson

At the time of Jeans' struggles with the emerging quantum theory, Cambridge was training its *last generations of wranglers*.[6] Among them, Charles Galton Darwin, Ralph Howard Fowler and George Paget Thomson are particularly relevant to this

[6] I use the expression "last generation of wranglers" in a rather loose way: 1909 was the last year in which Cambridge classified its MT students in the traditional hierarchical way and implemented

story, since they became, for different reasons, the first British actors in the history of quantum physics.

19.2.1 Charles Galton Darwin

Graduating fifth wrangler in 1909, Darwin had been coached in the Cambridge MT by Robert A. Herman, the most successful coach of his generation, and a firm supporter of Joseph Larmor's Electromagnetic Theory of Matter (Warwick 2003b). After his graduation he moved to Manchester, where Rutherford had built his experimental school of radioactivists. There, he did mathematical work on the scattering and diffraction of radiation, especially X-rays and α-rays, developing a theory on the structure of crystals as derived from the reflection of X-rays (Darwin 1914). He also did theoretical work on the atomic atom that Rutherford had recently put forward. To this time belong his *Theory of the Absorption and Scattering of α Rays* and his classical analysis of the possible orbits for an electron in a Rutherford-type atom (Darwin 1912). The latter paper shows him in continuity with Larmor's intellectual project, using Lorentz's formula of the "deformable" electron, which "besides being apparently in best agreement with experiment, makes possible a complete integration of the equations of motion" (Darwin 1913, p. 202).

After a purely theoretical training in the Cambridge MT, Darwin also developed his practical skills in Manchester where, contrary to the wrangler culture of Cambridge, experiment was at the very foundation of physics. Rutherford "espoused a much more physical, intuitive approach to theory in which the preferred result was an easily visualised picture, and preferable one suggestive of further experiment" (Hughes 1998, p. 343). And also in Manchester, Darwin met Niels Bohr, who moved to Rutherford's department in March 1912 after a disappointing experience in J.J. Thomson's Cavendish. This meeting proved important first for Bohr since, as Heilbron and Kuhn (1969, pp. 237–245) discussed in detail, his early ideas on the structure of the atom were indirectly triggered by Darwin's work on the absorption and scattering of α-rays.[7] In the long run, it was Darwin, however, who benefited most from this relationship.

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a thorough reform of the Mathematical Tripos, with more emphasis on pure mathematics. Notwithstanding these reforms, the ethos of the MT did not change immediately and MT students before the Great War can easily be labeled as wranglers of the last generation.

[7] In one of his first papers, Darwin had assumed that (i) the loss of energy of α-particles was due to interactions of these only with the electrons in a Rutherford atom, and (ii) that electrons could be considered to be free in the atom. In rejecting these two assumptions, Bohr shifted his interest from the behaviour of electrons to the structure of the atom. In a letter to his brother Harald on June 12, 1912, Bohr explains how "a couple of days ago I had a little idea for understanding the absorption of α-particles (the story is this: a young mathematician here, C.G. Darwin, (grandson of the right Darwin) has just published a theory about it, and I thought that it was not only incorrect mathematically … but also very unsatisfactory in its basic conception), and I have worked out a little theory about it, which … can perhaps shed a little light on some things concerning the structure of atoms" (in Heilbron and Kuhn 1969, p. 237).

After the Great War, Darwin moved back to Cambridge, where he was the first person to teach quantum theory. In the year 1920/1921, he taught "Recent Developments in Spectrum Theory", an optional advanced course to students in the Natural Science Tripos (NST), and in the following year, "The Theory of Quanta", this time to MT students. But what kind of quantum physics was Darwin advocating in the early years after the war? To summarise his approach briefly, one might say that Darwin, like Jeans before him, was convinced of the phenomenology of quantum physics, including aspects of Bohr's atom and Sommerfeld's orbits, but not of the fundamental assumptions of Planck's hypothesis and certainly not, like most other people at the time, of the quantum of light. In a letter to Bohr drafted in the summer of 1919, Darwin summarised his views on the current situation of physics stating that further experimental and theoretical work "would force us to look for our modification in Planck rather than in Maxwell" (Darwin 1919, p. 196); meaning that the solution to the contemporary problems in physics had to be sought in challenging the new theory of interaction between ether and matter (Planck and Einstein's laws of radiation), and not the many-times-confirmed Maxwellian framework for the behaviour of electromagnetic waves in the ether (which was in complete contradiction to the existence of free quanta of light). To do so, he was ready to give up, if needed, one fundamental principle of classical physics, i.e., the exact conservation of energy.

One might be tempted to call Darwin a revolutionary for wanting to abandon the strict conservation of energy, but this was only the consequence of an even more conservative attitude towards other elements of classical physics; i.e., (i) the wave theory of light, which "forms a consistent whole, but which at present only fits into the quantum theory with a good deal of difficulty", and (ii) that the "complete truth" lies in dynamics, even if it does not necessarily include an exact conservation of energy, which is "only one of the consequences of the dynamical equations" (Darwin 1923, p. 25). He certainly took for granted the validity of the wave theory "outside matter" and, with it, "the exact conservation of energy in the ether; it is in the interchanges with matter that it need not be conserved" (Darwin 1923, p. 26). And that was the old Maxwellian problem, which had kept so many physicists busy since the publication of the *Treatise of Electricity and Magnetism* in the 1870s: the interaction between ether and matter.[8] To put it differently, Darwin's openness to the abandonment of the strict conservation of energy was consistent with his *MT* background, since it was precisely in the interaction between ether and matter that Maxwell's system was not complete, and where any scientist with a tendency to grand speculation—as Darwin was—could feel free to suggest new ideas. For the same reason, the theory of a quantum of light as an alternative explanation to the propagation of light in the ether was totally out of the question, since Maxwell gave a complete account "outside matter" (Darwin 1923, p. 26).

[8] Perhaps the most significant example of this Cambridge culture was J.J. Thomson, whose whole research project on discharge tubes can be understood as basically an attempt to give continuation to Maxwell's *Treatise* by understanding the interaction between ether and matter. See Navarro (2005).

After a few months in CalTech, he accepted the chair of Natural Philosophy in Edinburgh in 1924, where his work showed an increasing determination to underline the continuity, rather than the discontinuity, between classical and quantum physics (Navarro 2009). More often than not, he claimed that both approaches must be related, following Bohr's "correspondence principle", which, in turn, legitimised the use of the old physics. But he increasingly realised that he was out of touch with the fast-changing quantum mechanics, especially after the formulation of Heisenberg's matrix mechanics. Was it, perhaps, time to change his approach to quantum mechanics and accept what was coming from Copenhagen? Darwin was genuinely interested in the problems of spectroscopy, statistics and atomic constitution, and he could see Bohr's school gaining huge momentum. But he was also certain that the tradition of physics to which he was heir could and should be pushed forward to give consistent explanations to quantum phenomena. In order to compare his and the new approach, he decided to spend some time in Copenhagen and learn and discuss the new physics first hand. Nevertheless, the outcome was not surrender, but a firm conviction that classical physics was more powerful than Bohr and Heisenberg's methods since the latter gave formal solutions but could not feed the imagination.

During his stay at the Institute for Theoretical Physics, Darwin developed his equation for the spinning electron based on Schrödinger's wave mechanics, in response to Pauli's (1927) theory of the magnetic electron that used the language of matrix mechanics. The central focus of my discussion here is Darwin's rhetoric in this and the next papers, which manifests his attitude in the face of the new quantum mechanics; a rhetoric that shows his increasing distance from the mainstream of quantum matrix mechanics and his loyalties to certain aspects of the old Cambridge physics, such as the importance of mechanical models and the efficacy of the analytical methods learnt in the MT, as well as the need to preserve as much as possible from the classical worldview.

Ironically, that visit convinced him of at least two things: (i) that quantum mechanics could be finally treated in continuity with the old physics by placing de Broglie's principle and Schrödinger's equation at the centre of the new physics; and (ii) that there was a radically new way to tackle so-far-unsolved problems in physics that was gaining much support among physicists, young and not so young—the last 'convert' being Bohr himself—, a method that, however useful and efficient, was a threat to the very essence of the scientific endeavour, since it did not give "a description of the *progress* of events" (Darwin 1927, p. 258).

When the young Dirac presented his theory for the electron in 1928, Darwin had to acknowledge its formal superiority, but he did not change his mind on the need to have some potentially visual mechanism for the processes in quantum physics. For Darwin, the need to have a visual representation was a *sine qua non* condition for true physics. What could not be imagined could not be real. Furthermore, it was only natural to expect continuity between the old and the new physics, and the wave formulation provided precisely that. The question was, however, what interpretation the wave function had since, in Schrödinger's formulation, the physically relevant magnitude is the square of the wave function. Darwin was keen to see ψ as something real, however unobservable—at least for the time being—and not just as a measure of all the possible states of a particular system. And to justify his take, he used an historical example: atomic theory. As he conveniently recalled, "it is doubtful whether we should ever have had a theory of relativity or a statistical theory of thermodynamics, if the condition of observability had been imposed when scientists first began to study dynamics or the theory of gases" (Darwin 1929, p. 392). In the same way atoms were not observable entities a hundred years before, the problem of the observability of ψ could be, for the time being, set aside, and we could content ourselves with its *interpretation*. In any case, it was obvious for Darwin that any future visualisation of ψ would come from its relationship with the language of waves, which were, for any MT physicist, clearly imaginable.

19.2.2 Ralph Howard Fowler

Darwin's most relevant work in the early years after the Great War was a series of papers he published with Ralph H. Fowler on the partition of energy (Darwin and Fowler 1922a, 1922b). Fowler was, at that time, a tutor and lecturer at Trinity College, Cambridge, where he had also been a student in mathematics (McCrea 1993). He had graduated in 1911, 2 years after the abolition of the order of merit, which gave him more flexibility to focus his studies on his real interest in pure mathematics, rather than on mathematical physics. It was only during his involvement in the war effort, inventing and directing operational anti-aircraft, that he shifted his attention to applied mathematics and theoretical and experimental physics. Unlike Darwin, who could learn the developments of the early quantum physics in the Manchester of Rutherford and Bohr, Fowler was self-trained in the theory of quanta. Like Darwin, he was one of the first British physicists to realise the fundamental importance of the new physics, to work on it, and to spread it among the British scientific public by, for example, translating into English many of the key papers that were appearing in German, as well as inviting people such as Ralph Kronig or Werner Heisenberg to give lectures in Cambridge. It is also well known that Fowler became a sort of *theorist-in-residence* at the Cavendish, as well as Rutherford's son-in-law.

Fowler's work with Darwin consisted basically of a mathematical technique to calculate exactly the contour integral in the function for the partition of energy, something that since the times of Boltzmann could only be done approximately. Their approach was, in principle, both classical and quantum, the former being a limited case of the latter, following Bohr's correspondence principle: "the possible states of the system may be divided into cells; these cells are fixed and finite for quantized systems, but for the systems of classical mechanics must ultimately tend to zero in all their dimensions" (Darwin and Fowler 1922b, p. 825). The real value of this work resided in the evaluation of the integral of the classical—continuous—case, rather than the summation of the quantum—discrete—system, which had no serious mathematical difficulty. For the argument of this paper, however, it is interesting to point out the fact that Darwin and Fowler justified their calculus as something valid for both quantum and classical physics, and emphasised that the two realms were united by the correspondence principle.

The direct collaboration between both Cambridge physicists ended when Darwin moved to the University of Edinburgh. Although now in different universities, Darwin and Fowler were the only two British physicists, *fellows* of the Royal Society, who could judge on quantum matters. This can be seen from the remaining referee reports for the *Proceedings of the Royal Society*, where they reviewed all papers related to quantum physics and quantum mechanics. This, in a way, turned them into the arbiters of quantum physics in Britain in the mid-1920s. Both thought that British physicists should be more active in the race to develop quantum physics, either by trying to solve specific problems (Fowler) or by giving alternative big frameworks (Darwin), and that is why they were keen to encourage the fast publication of the few papers on the topic submitted to the *Proceedings* (Kragh 1999:chap. 10).

One referee's report in particular witnesses to this. Dirac's (1926) paper on the "Quantum Mechanics and a Preliminary Investigation of the Hydrogen Atom" was published just 1 month after the reception of the manuscript. Dirac's early work in quantum physics was developed under the guidance of Fowler and thus Darwin refereed his papers. In his report, he wrote: "the paper is a very important contribution to the newest developments of physical theory. It is a brilliant piece of work, and should if possible be published quickly, as it is in a field where others are working in competition. It would be a pity if the author were to miss the credit for this work through being late in publishing" (Referee Reports, *Archives of the Royal Society*).

Darwin's approval of Dirac's work was only partial, since Darwin's own work after 1926 began to emphasise a priority of Schrödinger's wave mechanics over the matrix mechanics of Heisenberg, Pauli and Dirac. Fowler acted as referee to Darwin's papers and we can perceive a differentiating style between them, the former being less prone to speculation than the latter. In his report on the paper "Free Motion of the Wave Mechanics" (Darwin 1927), Fowler advised in the following terms:

> I don't quite like some of the remarks in the introduction as I think they are somewhat over bold, and I feel that a false contrast is drawn between matter and waves. The [subject matter?] is a calculus of linear operators, and matter and waves are equally forms of the same calculus in *all* respects. These points however are hardly inconsistent to the theme of the paper, and I do not recommend return to the author. It may even be that his remarks on these points be valuable just because they overstress the wave view, which has hitherto not been stressed enough. A very valuable paper (Referee Reports, *Archives of the Royal Society*, emphasis in the original.)

Actually, only a few months earlier, Fowler had written a very accessible—and enthusiastic—paper in *Nature* to explain matrix and wave mechanics, their equivalence, and their relationship with classical mechanics and the old quantum physics, where any supremacy of one view over the other was dismissed as "futile". Nevertheless, he condescended with the "majority of workers" who might find that "the wave mechanics, owing to the greater familiarity and convenience of its algebra, is the more powerful tool for solving any particular problem" (Fowler 1927, p. 241).

Fowler's attention to quantum mechanics in the late 1920s diverged from Darwin's approach also because the former was focused on practical problems of quantum mechanics; i.e., he was more interested in applying the principles and latest developments of quantum mechanics to new problems, especially to problems of chemical valence and chemical structure, rather than in challenging and discussing the very fundamentals of quantum physics. As Gavroglu and Simoes (2002) have argued, Fowler was instrumental in the establishment of an incipient research school on quantum chemistry in Cambridge in the 1920s, a school that included people such as J. Lenard-Jones, D.R. Hartree and C.A. Coulson, and that would eventually give way to a more established, Oxford-based, British research group in quantum chemistry from the 1930s onward.

19.2.3 George Paget Thomson

G.P. Thomson was born and raised in Cambridge, son of the charismatic Sir J.J. Thomson. From an early age, his father kept an eye on his scientific education to make sure that he would eventually make it to the higher ranks of the MT. As a matter of fact, by the time G.P. formally registered as a university student, he had already been coached in mathematics by high wranglers and attended experimental demonstrations in his father's laboratory (Navarro 2010). So much so that he managed to graduate in 1913 in both the MT and the *Natural Science Tripos* after the usual three years of residence in the university. Having spent all his formal training under his father's wings, the situation did not change after graduation or even after the impasse of the War. His postgraduate research and his early work as a young professor in the University of Aberdeen from 1922 followed in the steps of J.J. Thomson's project on the analysis of 'positive rays' (Falconer 1988). His knowledge and interest in quantum matters was very limited when, in the summer of 1926, he learnt that his experimental layout was potentially ideal for testing the recently formulated principle of wave-particle duality by Louis de Broglie.

Actually, G.P. Thomson was, together with Fowler, one of the few British physicists to pay attention to de Broglie's thesis. When learning about it from an English translation in the *Philosophical Magazine* of 1924, he interpreted it in a classical way, following a working tool of his father, the Faraday tubes, which were dynamic tubes of ether that connected electrified bodies. In that same year (1924), J.J. Thomson was working on his *nth* attempt to explain the photoelectric effect and the nature of light within his metaphysical framework in which the ether, and the Faraday tubes in it, were an essential element. His suggestion constitutes a very good example of the dynamical models that, as a former Cambridge *wrangler*, constituted one of his basic tools for reasoning (Topper 1980). Far from denying the experimental evidence for the quantum of light, J.J. stressed that this quantification was only the result of a process in the continuous medium. Assuming, as he did, that the proton and electron in the atom interacted by means of a Faraday tube connecting them, one could imagine what happened to the tube when an electron 'jumped' from one orbit of high energy to an orbit of lesser energy. The Faraday tube would first bend and then form a loop that would detach from the original tube: this would constitute the emission of a photon. Similarly, a quantum of radiation in the form of a closed loop of the Faraday tube, could be absorbed by the tube uniting a proton and electron, providing the energy for the electron to jump to a higher energy state (JJ Thomson 1924, 1925).

In a paper with the title “A Physical Interpretation of Bohr’s Stationary States”, G.P. Thomson tried to explain de Broglie’s radical hypothesis in continuity with his father’s framework. If the trajectories of electrons around the nucleus were understood in terms of waves, only those orbits in which the path was a multiple of the wavelength would be stable, a suggestion that gave similar results to Bohr’s quantification. G.P. Thomson’s suggestion was that these stationary states could be equally achieved following his father’s 1924 atomic model explained above. If proton and electron were united by a Faraday tube of force, ‘it will thus be able to transmit waves, and the condition that will be taken as determining the possible states is that the vibrations in this tube shall be in tune with the period of the orbit’ (Thomson 1925, p. 63). Thus, the physical properties of the Faraday tube uniting the electron with the nucleus would determine the waves accompanying the movement of the electron and, therefore, the possible orbits in an atom.[9]

This visual interpretation of de Broglie’s principle was totally out of touch with the underlying tenets from relativity and quantum theory, and he did not think of electronic waves in the sense of de Broglie. It was only a matter of chance that his experimental display in Aberdeen was ideal for testing the diffraction of free electrons. The discharge tubes attached to a photographic camera he was using for the analysis of positive rays were relatively easily modified to analyse the passage of cathode rays through thin films of several metals. This provided him with clear pictures of the diffraction of cathode rays and proof of the waves associated to massive particles.

In the run-up to these experiments, G.P. Thomson benefited from his close friendship with Darwin who, as we saw, spent the spring of 1927 in Copenhagen, where he could discuss the latest developments in quantum mechanics with Bohr, Heisenberg and Schrödinger, among others. On his way back, Darwin spent some time in Aberdeen, in G.P. Thomson’s home. This way, G.P. learnt the new wave mechanics from Darwin’s explanations.[10] The timing was just right. As G.P. Thomson was seeing with his own eyes the diffraction patterns of cathode rays, he understood them in light of Darwin’s explanations. At the same time, Darwin saw in those pictures a possible step towards a more visual understanding of quantum physics, more in tune with Schrödinger’s interpretation than with Heisenberg and Bohr’s.

[9] G.P. Thomson’s article only studies the hydrogen atom and ‘a simple extension of the above accounts also for the stationary states of ionized helium, and gives approximately the energy of the K ring of electrons’.

[10] Oral interview with G.P. Thomson, *Archive for the History of Quantum Physics*, Tape T2, side 2, 15.

Certainly, both Darwin and G.P. Thomson could feel at ease with a quantum mechanics that preserved a continuous ontology, as well as a need for visual explanations, since these were fundamental tenets in the way they were trained in physics, and these were somehow provided with the diffraction patterns obtained by G.P. Thomson. As for visual interpretations, an example G.P. Thomson often used in his popular lectures is that of the gossamer spider:

> When at rest this spider is a minute insect. When it wants to move it sends out streamers into the air, and floats away owing to the action of the air on these filaments which stretch out a foot or more all round it. Just so the electron, when it is part of an atom its waves are limited to that atom, or even to a part of it. They are curled round on themselves, as it were. Suppose, now, an electron escapes from the hot filament of a wireless valve and gets free. Its waves will spread far out into the space round it. I regard it as still a particle at the centre of its wave system. The analogy can be pressed further. If the wind sweeps the spider past an obstacle the filaments will catch. The pull on filaments will move the spider, and he will feel that there is something in the way, even though his body does not actually hit it. In the same way the waves are a means by which the motion of the electron is affected by things which the main body of the electron never comes very near. (Thomson 1929, p. 220)

This analogy can be seen as a pedagogical explanation of Darwin's idea that the wave function describes all the possible movements of the electron. G.P. Thomson and, certainly, Darwin were aware that the diffraction experiments entailed a turning point in physics; but a turning point that allowed for continuous explanations of Nature to regain their legitimacy, against the threat of an excessively discrete quantum physics.

G.P. Thomson shared the 1937 Nobel Prize with C.J. Davison and L.H. Germer, from the Bell Laboratories, for his experiments on electron diffraction. But neither he, nor the American team could play any active role in understanding and developing the new quantum physics. Indeed, in 1930, G.P. Thomson moved to a new chair at Imperial College, London, where he sought to find practical applications to what he called "electron diffraction cameras."

19.3 Teaching Quantum Theory in Cambridge

Having scrutinised the careers of the most influential wranglers of the last generation on quantum matters, let us now turn to the way the new theory entered the lecture room in Cambridge. We have already seen that Darwin was the first to teach an optional advanced course on atomic spectra and quantum theory. When he left, Fowler kept offering a similar module but it was soon realized that that was not enough. Quantum physics was growing worldwide and Cambridge started to teach advanced courses in the year 1924/1925. Not surprisingly, it was a young generation of graduate researchers, under the supervision of Fowler, who could teach the latest developments, since they were in close contact with Copenhagen and some German research centres.[11] Thus, we can find advanced courses taught by Dirac and

[11] Fowler, Hartree, and Dirac were visitors of Bohr's Institute in Copenhagen.

by Hartree in the second half of the decade; courses that were, especially in Dirac's case, but also in Fowler's and Hartree's, reflection of science in the making.

In the list of courses taught until the early 1930s we also find, however, a name hardly ever present in the histories of quantum physics: George Birtwistle. Born in 1877, Birtwistle arrived in Cambridge in 1895 and was bracketed senior wrangler in 1899. After this, he was appointed fellow and lecturer of mathematics in his own college, Pembroke, where he remained until his sudden death in May 1929. Like many dons of the old school, "it was as a teacher rather than as an investigator that Birtwistle was known, and as a teacher that he played a conspicuous part in Cambridge mathematics" (Anonymous 1929, p. 881).

Birtwistle was the author of the first two English books on quantum theory, *The Quantum Theory of the Atom* (1926) and *The New Quantum Mechanics* (1928), which are an open window to his lectures. Being no researcher in the field, Birtwistle's books are basically a summary of the state of the art at the time of publication. The first book was rather complete and accurate, except for a main problem: in 21 chapters one can never find words such as 'provisional', 'incomplete', 'failed explanation', or anything that indicates that the quantum theory of the atom, as it is, is incomplete or, worse, deficient. It is only in a rushed last chapter that Birtwistle introduces the reader to a list of unexplained phenomena like the anomalous Zeeman effect and the Paschen-Back effect, and to new theories, like the so-called BKS (after Bohr, Hendrik Kramers and John Slater) and the new quantum kinematics of Heisenberg. But there is no sense of stress, or crisis, or revolution. There are no value judgements. One gets the impression that everything explained, even in these last chapters, are just steps in the development of the new physics.

The book is an attempt to train students into the technique of quantisation using a twofold strategy: to provide lots of examples where quantisation is successfully applied, and to show that there is continuity in the methods used in 'classical' and quantum theory. Because, as he sees it, that is the only way one gets hold of the new physics: by using it, rather than by presenting it in a general form or analysing its conceptual or philosophical implications. That comes as no surprise. Birtwistle, a first wrangler in the MT, tried to teach quantum physics in the same way classical physics was taught in the Cambridge MT tradition: by repetition of examples, by solving specific problems, and by a relatively uncritical embrace of particular mathematical methods.

In the second of his books this pedagogical approach totally fails and the book is not recorded to have had much impact. It is possible that some bright students and future major physicists attended his lectures but forgot about them, influenced by the selective memory usual in this kind of recollections. But it is also likely that Birtwistle's courses were seen, already at the time, only as second best, as courses to be taken only by those wanting to get a feeling of the new theory, but not to master it so as to work on quantum problems. Actually, in a letter to Dirac, Fowler admits that Birtwistle's lectures are only meant for "complete beginners" who need "to get the ground work first."[12] This would explain why, among those scientists who became

[12] Fowler to Dirac, 12 June 1927, DRAC 3/1, Churchill College Archives.

in some degree actors of the new quantum generation, we cannot find students of Birtwistle (some of them actually remember his elementary lectures in mechanics and electricity, but not on quantum theory). A last anecdote about this book comes from William McCrea, who was an undergraduate in Cambridge between 1923 and 1926. Talking about *The New Quantum Mechanics*, he recalled: "it was a remarkable achievement to produce such a comprehensive account of work newly published during the 2 years before the appearance of the book itself. Hartree described it to me in conversation as the 'bare bones' of the subject, but it need not be only medical students who find it useful to have a skeleton for their studies" (McCrea 1985, p. 58, see also McCrea 1987).

This conversation is significant for it shows that Cambridge graduate students were, in the mid-1920s, aware of the limitations of some of their professors on matters related to the quantum. A new generation was growing under Fowler's wings, and he was wise enough to get his brightest students in permanent contact with the sources of the new theory, sources that were overseas.

19.4 Conclusion: Peripheral or Central?

The purpose of this paper has mainly been to address the question of how Cambridge physicists trained before the Great War understood the budding quantum theory, paying attention to those who *did* engage with the theory and thought of themselves as actors on quantum matters. In all cases we have encountered the influence of a certain way of understanding the work of the theoretical physicist: based on model building, in continuity with nineteenth-century mathematical analysis and Maxwell's electromagnetism, and within the problem-solving culture of the MT that did not allow for much challenging of the very foundations of physics. Even in the case of Fowler, who eventually succeeded in triggering a school of quantum theory in Cambridge, he did so by avoiding the big questions and by paying attention to specific problems. In this way he contributed to the creation of the new discipline of quantum chemistry. As for the other four characters, Jeans abandoned Cambridge and became mainly a popularizer of relativity and astrophysics; Darwin in Edinburgh and Thomson in Aberdeen and London did not engage students of theirs into further research in quantum physics; and Birtwistle died unexpectedly in 1929 and had never done any research at all.

By the end of the 1920s quantum physics was, indeed, present in Cambridge. The case of Dirac, who came from a totally different scientific tradition and became the main British actor in the quantum field, has been studied at large. The old university, however out of touch with quantum theory at the beginning of the 1920s, was certainly a pole of attraction for many bright graduate students like him; and Fowler was wise enough (and had the means) to encourage his supervisees to spend time in Copenhagen, in Bohr's institute. Besides, and contrary to other "peripheral" universities, there was in Cambridge enough critical mass so as to make it easier for a research school on quantum physics to emerge. The famous informal meetings of the Kapitza Club, for instance, where research students and guests shared the latest novelties, could easily happen in the free environment of Cambridge colleges. Finally, the prestige of a place like Cambridge cannot be underestimated in understanding how the university could quickly enough catch up with quantum physics. A clear example is the way Dirac became Lucasian professor in the university. After publishing his equation for the electron in 1928, he was offered professorial chairs in several universities, but the expected retirement of Joseph Larmor, the incumbent Lucasian professor, encouraged him to wait until that opportunity materialized—which happened in 1932 (Kragh 2003).

Finally, and to tie up with Bohr's enthusiastic letter to Rutherford in 1932 mentioned in the introduction, the experimental project of the Cavendish generated unavoidable theoretical needs that had to be met *in situ*. Two examples are particularly relevant here. As is well known, one of the major outputs of the Cavendish in 1932 was the first splitting of the atom with the Cockcroft-Walton accelerator. This long-term, high-budget research project would be unthinkable without reasonable theoretical analysis in support of the possibility of splitting the atom (Hughes 1998). And Fowler and his students provided that. Also George Gamow, who arrived in Cambridge in 1928 with a daring but successful theory of alpha decay based on the tunnel-effect (itself a consequence of Heisenberg's principle), helped convince Rutherford of the relevance of the new quantum mechanics. The old university was thus back in the limelight of theoretical physics.

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References

Anonymous. 1914. Discussion on Radiation. In Report of the Eighty-Third Meeting of the British Association for the Advancement of Science Birmingham 1913, 376–386. London: John Murray.

Anonymous. 1929. Obituary. *Nature* 123:881.

Birtwistle, George. 1926. *The quantum theory of the atom*. Cambridge: Cambridge University Press.

Birtwistle, George. 1928. *The new quantum mechanics*. Cambridge: Cambridge University Press.

Darwin, Charles G. 1912. A theory of the absorption and scattering of the α rays. *Philosophical Magazine* 23:901–920.

Darwin, Charles G. 1913. On some orbits of an electron. *Philosophical Magazine* 25:201–210.

Darwin, Charles G. 1914. The theory of X-ray reflexion. *Philosophical Magazine* 27:315–333.

Darwin, Charles G. 1919. The basis of physics. In Sanchez-Ron, José M. 1981. "Aspectos de la crisis cuantica en la fisica britanica." Llull 4:181–198.

Darwin, Charles G. 1923. A quantum theory of optical dispersion. *Proceedings of the National Academy of Sciences of Washington* 9:25–30.

Darwin, Charles G. 1927. Free motion in the wave mechanics. *Proceedings of the Royal Society* 117:258–293.

Darwin, Charles G. 1929. A collision problem in the wave mechanics. *Proceedings of the Royal Society* 124:375–394.

Darwin, Charles G., and Ralph H. Fowler. 1922a. On the partition of energy. *Philosophical Magazine* 44:450–479.

Darwin, Charles G., and Ralph H. Fowler. 1922b. On the partition of energy. Part II. Statistical principles and thermodynamics. *Philosophical Magazine* 44:823–842.

de Broglie, Louis. 1924. A tentative theory of light quanta. *Philosophical Magazine* 47:446–458.

Dirac, Paul A.M. 1926. Quantum Mechanics and a preliminary investigation of the hydrogen atom. *Proceedings of the Royal Society* 110:561–579.

Falconer, Isobel. 1988. J.J. Thomson's work on positive rays. *Historical Studies in the Physical Sciences* 18:265–310.

Forman, Paul. 1971. Weimar culture, causality, and quantum theory: Adaptation by German physicists and mathematicians to a hostile environment. *Historical Studies in the Physical Sciences* 3:1–115.

Fowler, Ralph H. 1927. Matrix and wave mechanics. *Nature* 119:239–241.

Gavroglu, Kostas, and Ana Simões. 2002. Preparing the ground for quantum chemistry in Great Britain: the work of the physicist R.H. Fowler and the chemist N.V. Sidgwick. *British Journal for the History of Science* 35:187–212.

Gavroglu, Kostas, Manolis Patiniotis, Faidra Papanelopoulou, Ana Simões, Ana Carneiro, Maria P. Diogo, Jose R. Bertomeu-Sanchez, Antonio García-Belmar, and Agustí Nieto-Galan. 2008. Science and technology in the European periphery: Some historiographical reflections. *History of Science* 46:153–175.

Heilbron, John, and Thomas Kuhn . 1969. The genesis of the Bohr atom. *Historical Studies in the Physical Sciences* 1:211–290.

Hudson, Robert. 1989. James Jeans and radiation theory. *Studies in the History and Philosophy of Science* 20:55–77.

Hughes, Jeff. 1998. 'Modernists with a vengeance': Changing cultures of theory in nuclear science, 1920–1930. *Studies in the History and Philosophy of Modern Physics* 29:339–367.

Hughes, Jeff. 2000. 1932: The Annus Mirabilis of nuclear physics? *Physics World* 13:43–50.

Jeans, James. 1904. *The dynamical theory of gases*. Cambridge: Cambridge University Press.

Jeans, James. 1914. *Report on radiation and the quantum theory*. London: The Electrician.

Kim, Don-W. 2002. *Leadership and creativity*. Dordrecht: Springer.

Kojevnikov, Alexei, Cathryn Carson, and Helmut Trischler. 2011. *Weimar culture and quantum mechanics: Selected papers by Paul Forman and contemporary perspectives on the forman thesis*. London: World Scientific Press.

Kragh, Helge. 1999. *Quantum generations. A history of physics in the twentieth century*. Princeton: Princeton University Press.

Kragh, Helge. 2003. Paul Dirac. The purest soul in an atomic age. In *From Newton to Hawking. A history of Cambridge University's Lucasian Professors of Mathematics,* ed. Kevin C. Knox and Richard Noakes. Cambridge: Cambridge University Press.

McCrea, William. 1985. How quantum physics came to Cambridge. *New Scientist* 11:58–60.

McCrea, William. 1987. Cambridge 1923–6: Undergraduate mathematics. In *The making of physicists,* ed. Rajkumari Williamson, 53–66. Bristol: Hilger.

McCrea, William. 1993. Sir Ralph Fowler, 1889–1944: A centenary lecture. *Notes and Records of the Royal Society of London* 47:61–78.

Milne, Edward A. 1952. *Sir James Jeans, a biography*. Cambridge: Cambridge University Press.

Navarro, Jaume. 2005. J.J. Thomson on the nature of matter: Corpuscles and the continuum. *Centaurus* 47:259–282.

Navarro, Jaume. 2009. 'A dedicated missionary'. Charles Galton Darwin and the new quantum mechanics in Britain. *Studies in the History and Philosophy of Modern Physics* 40:316–326.

Navarro, Jaume. 2010. Electron diffraction chez Thomson. Early responses to quantum physics in Britain. *British Journal for the History of Science* 43:245–275.

Pauli, W. 1927. Zur Quantenmechanik des magnetischen Elektrons. *Zeitschrift fur Physik* 43:601–623.

Thomson, George P. 1925. A physical interpretation of Bohr's stationary states. *Philosophical Magazine* 1:163–164.

Thomson, George P. 1929. New Discoveries about electrons. *The Listener* 1:219–220.
Thomson, Joseph J. 1924. A suggestion as to the structure of light. *Philosophical Magazine* 48:737–746.
Thomson, Joseph J. 1925. *The structure of light: The Fison memorial lecture*. Cambridge: Cambridge University Press.
Topper, David. 1980. 'To reason by means of images': J.J. Thomson and the mechanical picture of nature. *Annals of Science* 37:31–57.
Warwick, Andrew. 2003a. *Masters of theory*. Chicago: Chicago University Press.
Warwick, Andrew. 2003b. The universal aethereal plenum: Joseph Larmor's natural history of physics. In *From newton to hawking. A history of Cambridge University's Lucasian Professors of mathematics,* ed. Kevin C. Knox and Richard Noakes. Cambridge: Cambridge University Press.

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Chapter 20
From the Museum to the Field: Geology Teaching in the Faculty of Sciences of the University of Lisbon

Teresa Salomé Mota

20.1 Introduction

> I really enjoyed the fieldwork—it's where everything began to make sense.
> [Anonymous graduate in Geological Sciences from the University of Leeds (Butler 2008)]

Both geologists and historians of geology have long acknowledged the unique role of fieldwork in geological practice and hold that it is a distinctive feature of geology and geosciences in general. A significant amount of historical literature has been published on the emergence of geology and the role played by fieldwork practice (Oldroyd 1996; Torrens 2002; Rudwick 2004, 2005), the central role of fieldwork in the development of geological knowledge (Freeman 2001; Vetter 2004), fieldwork practice associated with national geological surveys (Corsi 2003; Oldroyd and McKenna 2005; Carneiro 2005), geological fieldwork and research schools (Secord 1986), and notable field geologists (McCartney 1977), just to mention a few. And there are the seminal works of Rudwick and Oldroyd that invite readers to follow geological fieldwork 'in the making' in nineteenth century Britain; they also unveil some particularities of the construction of geological knowledge, from the difficulties faced by geologists to make sense of fieldwork data in the light of theoretical assumptions to the social process of scientific consensus achieved by the geological community (Rudwick 1985; Oldroyd 1990).

Geological fieldwork is considered a fundamental part of geology teaching: it favours observation, improves visualisation skills such as three-dimensional perception, allows for the synthesis of a range of previously obtained theoretical knowledge, is an ideal mean for the confrontation between data, interpretation and uncertainty due to the multiplicity of factors inherent to geological processes. Besides that, fieldwork enhances personal development through increased self-reli-

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ance and team building (Butler 2008). However, historical literature on geological fieldwork training in educational contexts is scarce. In fact, geology teaching in general does not seem to have yet called the necessary attention from historians of geology. It is as if the gap that existed for so long between the history of science and the history of education has still not been overcome in the case of geology.

Kuhn and Polanyi were among the first to draw attention to training of scientists, namely by highlighting the role of exercises and exemplary problems and the centrality of 'tacit knowledge', respectively (Kuhn 1962; Polanyi 1958). In the last two decades, methodological developments in the history of science and history of education led to a revision on the approaches, tools and questions concerning the study of science teaching and its institutionalisation.

Nowadays, science teaching is portrayed as the result of the interplay of scientific knowledge and pedagogical methods, strongly shaped by social, economic and political factors (Christie and Golinski 1982; Olesko 1991; Belhoste 2003). The use of textbooks, students' notebooks and lecture courses became a favoured primary source because they are placed at the crossroad of the 'multiple and diverse factors and actors' that determine scientific educational practices (Bensaude-Vincent et al. 2004; Bertomeu-Sanchez et al. 2006; Carneiro et al. 2006). New and specific problems arise because 'learning to be a scientist' is not the same in different and specific local contexts (Kaiser 2005), be it astronomy in Portugal during the nineteenth century (Carolino 2012) or mathematical physics in Cambridge around the same time (Warwick 2004).

As has already been stated, this comprehensive historiographical change did not have a significant repercussion on the historiography of geology and Portuguese authors are no exception. There are some more conventional works dedicated to professors of geology (Ribeiro 1958–1960), geology teaching in higher teaching institutions, such as the University of Coimbra (UC) and the Polytechnic School of Lisbon (PSL) (Costa 1937; Ferreira 1998), or even to geology teaching as a whole (Antunes 1989). More recent studies try to catch up with the latest historical trends, placing and understanding geology teaching in its appropriate context and relaying, for instance, on the use of textbooks, courses syllabus and students' notebooks as primary sources (Amador 2008; Mota 2008, 2011).

The present work intends to be a contribution to this new approach. It addresses the introduction of fieldwork training in geology teaching at the Faculty of Sciences of the University of the Lisbon (FSUL). Meanwhile, it presents an overall account of geology teaching in the FSUL during the first half of the twentieth century and in the preceding nineteenth century institution, the PSL. During this period, geology in Portugal was most of all a teaching subject; geological practice and research almost did not exist except for the Portuguese Geological Survey (PGS), where geology was practised according to international standards.

We will see that during the nineteenth century and the first decades of the twentieth, geology teaching and research in the PSL and the FSUL had a characteristic natural-historical character, which was closely related to the status and purposes of geological knowledge in the two institutions in particular and in Portuguese society in general. Those circumstances changed somehow in the 1940s and 1950s, when the most recent geological knowledge found expression in the syllabus of faculty courses and the urge for the development of scientific research in the FSUL became more pressing.

By then, Carlos Teixeira (1910–1982), a professor of geology in the FSUL, advocated that fieldwork was essential in the training of future geologists and should hence be part of geology teaching in the universities. Nevertheless, the logistics of fieldwork were revealed to be quite complex and too expensive to be carried out by the FSUL. In order to overcome this situation, Teixeira created a 'school of geological fieldwork' in the PGS, which ended up as an extension of his own research school at the FSUL. This school tightened the relations between the FSUL and the PGS and was used simultaneously by members of Portuguese geological community to assert their interests.

20.2 Geology Teaching During the Nineteenth Century: The 7th Course in the Polytechnic School of Lisbon (PSL)

Geology emerged in most European countries during the first half of the nineteenth century. The establishment of mining schools, the formation of geological and paleontological collections, the practice of fieldwork associated with geological mapping and the constitution of scientific societies were distinctive and decisive factors in the process. Both private and public institutions became committed to the study and practice of the new science, giving rise to a 'geological culture' (Knell 2000).

In Portugal, such circumstances did not apply; apart from a privileged elite, geology was unfamiliar to most people and thus the most convenient way to implement this science was through State initiative (Carneiro 2005). As a consequence, geology arose in Portugal as a State Science following the establishment of the PGS (Carneiro 2005; Carneiro and Leitão 2009).

Besides the PGS, the only other public institutions that addressed geology in Portugal during the nineteenth century were schools of higher instruction, namely the UC, the PSL and the Polytechnic Academy of Oporto.[1] The first served as reference[2] when geological teaching was established in the PSL and the Polytechnic Academy.

[1] The Army School was reorganized in 1897 and a course named Applied Geology was established. It was the first time that the word *geology* appeared in the institutional *curricula.*

[2] In 1772, the Portuguese Prime Minister Marquis of Pombal established the reform of the UC. A course in natural history was created in the new Faculty of Philosophy. The syllabus of the course was centred in the description and classification of natural objects and it presented the utilitarian overtone characteristic of eighteenth century natural history. In 1791, a course on zoology and mineralogy and another in botany and agriculture replaced the previous one. The first course dedicated only to geological subjects was established in 1836 and was named Mineralogy, Geognosy and Metallurgy; its syllabus maintained the descriptive and utilitarian character of previous courses (Carvalho 1986; Ferreira 1998; Costa, 2000).

The PSL was created on 11 January 1837 with the aim of enabling students with the required knowledge to follow subsequent courses in the Army School and in the Navy. It also offered the possibility of obtaining a general higher instruction and a subsidiary one for those who wanted to pursue a career in science (Decree 1837).[3] The PSL was the preliminary step in the scientific formation of the future State technical staff that would complete its training in military technical schools (Carolino 2012). It was therefore a characteristic institution of the Portuguese liberal regime in its attempt to build a modern nation. Public instruction acquired a major role in this process: it was considered a State obligation and consequently the liberal regime initiated a series of reforms. In 1836, a particularly significant one took place, leading to the creation of *lycées* and technical schools and setting the outlines of the Portuguese educational system, which was maintained almost unchanged throughout the century.[4]

Geological subjects were taught at the PSL in the 7th course (7ª cadeira), named Mineralogy, Geology and Principles of Metallurgy (Mineralogia, Geologia e Princípios de Metalurgia), a course that should be attended by future military and civil engineers, Army officers and those who wanted to proceed to a scientific career. Artillery officers also had to attend the part of the course concerning the Principles of Metallurgy (Decree 1837). In 1856, the latter was set apart and taught in a new course, Montanistic and Docimasy (Montanística e Docimasia), which had an ephemeral life: it ceased in 1868 (Decrees 1852, 1856, 1868).[5] In 1898, the Council of the PSL recognised that students did not get a good preparation in geology when attending the 7th course and decided that mineralogy and geology should be taught separately in different courses in two successive academic years (Decree 1898). However, the measure was never put into practice. It must be stressed that even the professors of the 7th course were keen to admit that most lessons dedicated to geology were not taught. In 1902, mineralogy became part of the preparation of high-school teachers of mathematics, natural and physical sciences and drawing (Decree 1902).

Once the Principles of Metallurgy was removed from the 7th course, most of its lessons were devoted to mineralogy: 55 totalling 100. Preference was given to subjects relating to the description and classification of minerals, and the study

[3] Law published on 11 January 1837. The PSL was created under the Ministry of War; the Polytechnic Academy was created 2 days later. The PSL became part of the Ministry of the Kingdom in 1859 (law published on 7 July 1859) and was reorganised in 1869 (decree published on 14 December 1869). In April 1890, the PSL was transferred to the Ministry of Public Instruction and Fine Arts (Decree published on 5 April 1890).

[4] This reform became known as the ‘Passos Manuel reform’. Manuel da Silva Passos (1801–1862), known as Passos Manuel, was minister in several governments during the Portuguese liberal regime.

[5] The course on Montanistic and Docimasy was established in 1852 but classes only began in 1856, when Isidoro Emilio Baptista (1815–1863) was appointed professor. In 1859, the Council of the PSL decided to transfer the course to the Industrial Institute; however, it seems that it never came to function effectively in this technical school. The course came to an end in the PSL when Baptista died in 1863 but it was only legally suppressed in 1868. Due to the short existence of the course on Montanistic and Docimasy, it will be not analysed in this paper.

of geometric crystallography was widely developed. Regarding geology, a dozen classes were intended for the study of rocks, which shared the descriptive approach presented in mineralogy. The study of phenomena associated with rock formation and theories concerning Earth history were addressed in the 30 remaining lessons. Only one lesson, the last one, concerned mineral deposits of economic interest (Anonymous 1857).[6]

The syllabus of the 7th course did not change much over the years; its overall structure remained the same with only minor occasional alterations. In the academic year 1864–1865, the study of the relationship between the crystal structure of minerals and their chemical composition was introduced and so was the study of crystal systems with emphasis on the theories of René Just Haüy (1743–1822). Concerning geology, the brief study of phenomena having a more causal character, such as earthquakes and volcanoes, was also approached. Other novelties were the study of ice age theory and of Élie de Beaumont's (1798–1874) theories on the structure of the cooling Earth but most significant was the introduction of the major divisions of Earth history based on organic evolution through time: Palaeozoic, Mesozoic and Cenozoic (Anonymous 1865).[7]

Regarding practical classes, little is known about how they unfolded but it seems that they were mainly demonstrative with predominance of the role played by professors and without much effective involvement of students. Practical assignments comprehended almost exclusively the description, identification and classification of mineralogical, lithological and paleontological specimens belonging to the Mineralogical Section of the Museum of Natural History, which was part of the PSL. Crystallographic exercises were solved through geometric operations, disregarding the use of crystallographic models. Chemical and blowpipe analysis used in the determination of mineral composition were also performed to a limited extent (Anonymous 1857; Anonymous 1865).[8]

Students who attended the 7th course in the PSL, many of whom would become future military engineers, learnt basically to describe and classify specimens and to solve exercises of geometric crystallography. The study of geological subjects related to historical and causal aspects of the Earth was neglected. Altogether, the 7th course presented a natural-historical character, having as its first—and already distant—reference the study of natural sciences at UC. The first professor of the 7th course, appointed in 1840, was António Francisco Pereira da Costa (1809–1888), who had a degree in medicine and natural philosophy from UC. All those who followed Pereira da Costa as professors of the 7th course were his former students to whom he served as a model. Hence, the natural-historical characteristics presented by the 7th course were in part due to the training and performance of its professors, who did little more than reproduce what they learnt the way they learnt, without introducing any noteworthy changes to their classes.

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[6] Manuscript primary sources: Students' notebooks on mineralogy and geology, 7th course of the PSL, 1892, (Historical Archive of the National Museum of Natural History and Science)

[7] *Idem*.

[8] *Idem*.

20.3 Geology Teaching in the Faculty of Sciences of the University of the Lisbon (FSUL): The Degrees in Natural-Historical and Geological Sciences

In 1911, the First Republic abolished the PSL and two new universities were created: one in Lisbon and another in Oporto (Decree 1911a). A Faculty of Sciences was established in each of the three Portuguese universities, intended for the teaching and research of mathematics, physics, chemistry and natural-historical (geology and biology) sciences (Decree 1911b). Science was perceived by the new regime as knowledge that deserved to be studied and practiced by itself and not only as a general and subsidiary preparation for further studies in more applied areas, such as engineering and medicine. Scientific research became particularly significant in the new Portuguese academic context, which took the nineteenth-century German university as a model. The new faculties of sciences were intended to assert themselves both as educational and scientific institutions, being one of their main goals the training of students in scientific research (Simões et al 2013).

Despite the good intentions expressed by the republican regime concerning the status of science teaching and research in the universities, the panorama of geology teaching did not change much. A true degree in geology was not created; only one in Natural-Historical Sciences comprehended the study of geology and biology, which attests to the low degree of specialization of these two sciences in Portugal at the time. Subjects related to geology were taught in the following courses: Mineralogy and Geology, Mineralogy and Petrology, Crystallography, Geology, Physical Geography and Earth Physics, Palaeontology. The analysis of the syllabus courses reveals that geological subjects were approached identically to what happened in the PSL (Decree 1911c).

The courses on Mineralogy and Petrology, Crystallography, Physical Geography and Earth Physics, Geology and Palaeontology were little more than the expansion of subjects taught in the 7th course of the PSL. As for the course on Mineralogy and Geology—solely intended for future engineers—it was basically a copy of the entire syllabus of the 7th course. The course on Physical Geography and Earth Physics was mainly attended by students of the degree in History and Geography and consisted of a variety of subjects, many of them only remotely related to geology. Even if the general structure of the various syllabuses conferred a less anachronistic character to the new courses when comparing to the 7th course, the description and classification of minerals, rocks and fossils and the study of crystallography continued to impose over causal and historical geology. Geology continued to be treated in a brief and general manner (Anonymous 1916).

The importance given to practical classes in the new faculties of sciences is undeniable: they were considered crucial in the training of future researchers. Most of practical classes took place in the Museum and Laboratory of Mineralogy and Geology[9] and in order to complete the degree in Natural-Historical Sciences students

[9] When the PSL was closed and the FSUL was established in 1911, the former Mineralogical Section of the Museum of Natural History became the Museum and Laboratory of Mineralogy and Geology.

had to work in the Museum for 2 years. Practical assignments recommended by the course syllabuses shared the natural-historical character presented by theoretical classes: they were mainly dedicated to the description, identification and classification of specimens. Students were required to collect rocks and minerals, describe and draw them macroscopically and microscopically and classify the samples. In the case of minerals, students were also asked to determine their physical and chemical properties, for instance by using the Mohs scale in the first case and by performing chemical and blowpipe analyses in the second. In the study of crystallography, students had to solve exercises using crystallographic models and goniometers. Geological excursions were also foreseen but the practice of fieldwork and mapping was not (Anonymous 1916).

In 1930, a new degree in Geological Sciences and another in Biological Sciences replaced the one in Natural-Historical Sciences in the three Portuguese universities (Decree 1930). Even if the new political regime, the Estado Novo,[10] was not particularly concerned with the support of Portuguese instruction or the development of science teaching and research, the degrees in Geological and Biological Sciences were created with the intention of fostering study in those scientific areas. During the Estado Novo, the university had as one of its prime missions the preparation of the ruling elite; accordingly, the regime supported university teaching—at least in theory—in those areas of knowledge that were considered important in this desideratum.

The degree in Geological Sciences lasted 4 years: the first two—comprehensive courses on mathematics, physics, chemistry and biology—were intended to give students a general scientific foundation and the remainder were dedicated to specialisation in geology. Courses on topography and topographic drawing were introduced so that students should have the knowledge and skills used in the description and representation of land surfaces (Decree 1930).

The courses that were part of the new degree remained very much the same but their syllabus and the overall *curriculum* changed. The changes in course syllabus reflected the development of scientific knowledge in the previous three to four decades, not only in geological sciences but also in physics and chemistry. Many subjects approached in the courses of Mineralogy and Geology, Mineralogy and Petrology and Crystallography comprehended data, concepts and laws from those two sciences, such as the study of optical, thermal, electrical and magnetic properties of minerals or issues related to the constitution of matter and to radioactivity (Anonymous 1933–1934).

Description and classification continued to have a prominent role in the degree in Geological Sciences but geological subjects showed further development and terminology revealing scientific updating. In the Mineralogy and Petrology course, for instance, the origin and differentiation of magmas became a major issue while the Palaeontology course dealt with wide theoretical considerations related to the

[10] The Estado Novo was a dictatorship formally established in 1933 by António de Oliveira Salazar.

study of living beings with an evolutionary perspective. Concepts such as 'facies' and 'biozone' were also introduced for the first time (Anonymous 1933–1934).

Causal and historical aspects of geology were still underrepresented but it is possible to notice the 'blurring' of the natural-historical approach exhibited by the previous degree. The study of subjects such as tectonics, seismology, deformations and displacements of the Earth's crust and Earth history were well structured, particularly the latter, with geological features of mainland Portugal being read and interpreted historically from geological maps (Anonymous 1933–1934).

In general, it can be said that the creation of the degree in Geological Sciences led to changes in geology teaching in the FSUL. It revealed a more theoretical and specialised approach that replaced the generalist and anachronistic one characteristic of the degree in Natural-Historical Sciences. This shift was mostly due to the updating and development of geological knowledge and the introduction of concepts and theories coming from physics and chemistry. On the other hand, it was related to the intention to train future researchers in geological sciences, an attempt to counteract the trend that most graduates showed—to follow a career as high-school teachers.

The circumstances surrounding the creation of the faculties of sciences reveal the perception of the laboratory as a model for the practice of scientific research. However, experimental work in the laboratory, *tout court*, is not a distinctive feature of geological practice. In the first three decades of the FSUL, geological research was rare and incipient and it basically involved cabinetwork with the identification and classification of mineralogical, lithological and paleontological specimens, thus reinforcing the natural-historical approach presented by teaching. By the end of the 1930s, things began to change. The setup of two laboratories, one for the preparation of thin sections and another for the performance of chemical analyses, led to the intensification of microscopy studies and chemical analysis of rocks and minerals, so far almost inexistent. Isotopic geology and the determination of mineral specimens by physical methods, X-ray in particular, also became preferential areas of research, inserted in the wider context of nuclear research, which was carried out in the Physics Laboratory of the FSUL (Gaspar 2009; Simões et al 2013).

Thus, from the end of the 1930s to the 1950s, geological research in the FSUL acquired a more 'laboratorial' approach. Professors and researchers began to publish on a regular basis and studies with a more analytical and interpretative character dedicated to mineralogy, petrology and geochemistry grew in number. However, research in the FSUL was still distant from typical geological research: it lacked fieldwork practice. And only fieldwork allows for what can be considered the 'heart' of geology: the reading and interpretation of landscape in a way that enables the (re)construction of its geological history.

20.4 Carlos Teixeira and the Establishment of a 'School of Geological Fieldwork' in the Portuguese Geological Survey

The above outline was the panorama of geology teaching in the FSUL when Carlos Teixeira became professor of geology in the institution in 1946. Although he was trained as a naturalist after finishing his degree in Natural-Historical Sciences in the Faculty of Sciences of the University of Oporto (FSUP), Teixeira was by then becoming a gifted fieldwork geologist. In the years to come, he would assert himself as a role model in terms of fieldwork practice in the Portuguese geological community.

Teixeira's training in geological fieldwork resulted from several contributions. The earliest ones were the geological excursions he made with Rui Correia de Serpa Pinto (1907–1933) while taking the degree in Natural-Historical Sciences between 1929 and 1933. Serpa Pinto was a mathematician and an engineer who became interested in archaeology and geology. He was appointed assistant professor of geological sciences in the FSUP in 1930 and also belonged to a research school in anthropology and pre-historic archaeology that António Augusto Esteves Mendes Correia (1888–1960), a well-known Portuguese anthropologist who developed his scientific and political career at FSUP during the first half of the twentieth century. Teixeira joined the school after finishing his first degree in 1933, the same year that Serpa Pinto died prematurely (Gonçalves 1976).

In 1938, when Teixeira was preparing his Ph.D., the *Instituto para a Alta Cultura* (Institute for Higher Culture) granted him a scholarship to do geological research in the Geological Institute of the University of Lille. This institute was renowned for its tradition in geological fieldwork and Teixeira had the opportunity to work with some recognised French geologists. The scholarship also gave Teixeira the opportunity to travel around Europe and get acquainted with scientific research in France, Belgium and Switzerland (Gonçalves 1976; Zbyszewski and Gonçalves 1983).

Notwithstanding, perhaps the most significant contribution to Teixeira's training as a field geologist was his scientific collaboration with the PGS. This gave him the chance to work with the French geologist Georges Zbyszewski (1909–1999)—they had already met in Paris—and the skilled field assistants. Teixeira was officially appointed collaborator of the PGS after he had finished his PhD in 1944. It was as a scientific collaborator of the institution that he was the author or co-author of several geological maps (Gonçalves 1976; Zbyszewski and Gonçalves 1983; Ribeiro 1989).

Teixeira was convinced that the field is the real laboratory in geology and fieldwork is the quintessential characteristic of this science. And just like other members of the Portuguese geological community, he considered that geological fieldwork training was crucial if one decided to graduate real geologists in Portugal. Teixeira was particularly critical with regard to the degree in Geological Sciences, which he considered to have the sole purpose of training high-school teachers. He advocated the reorganisation of the entire degree in order to accommodate training in geological fieldwork:

> (…) having a degree is not enough to become a geologist (…) it is necessary to have not only extensive theoretical knowledge but also large fieldwork practice to be called a geologist (…).
> (Teixeira 1950).

Still, Teixeira recognised that the FSUL did not have the required means to undertake fieldwork training (Teixeira 1956, 1967).

Therefore, how did he achieve his aim? Carlos Teixeira was a man with significant institutional power: besides being a professor in the FSUL, he also held important positions in other public scientific institutions, such as the Junta de Energia Nuclear (Council for Nuclear Power) and the Junta de Investigação Científica do Ultramar (Council for Colonial Research). Despite not being politically committed to the Portuguese dictatorship, Teixeira benefited from the support provided by several personalities with institutional and political relevance during the Estado Novo and he took advantage of this situation to enforce his own scientific interests and those of the Portuguese geological community. As a scientific collaborator of the PGS, Teixeira acted with a considerable degree of freedom in the institution and all points to the fact that he was the main person responsible for the establishment of a 'school of geological fieldwork' in the PGS.

In 1959, the PGS began to provide training in geological fieldwork to senior students of the degree in Geological Sciences. Most students came from the FSUL. Fieldwork training lasted for a month and consisted primarily in geological surveying associated with mapping. The students worked in groups during summer months mainly supervised by PGS geologists and field assistants who played a central role in student training. Notwithstanding, Teixeira was almost always directly involved in students' supervision: he visited them in the field quite often, giving instruction and advice. He was free to decide where the students should make their surveys and later on some of Teixeira's own disciples became responsible for supervising students' fieldwork. The students' work was used in some of the sheets of the Geological Map of Portugal at the scale 1:50,000 made and published by the PGS. Students' authorship was sometimes acknowledged but in most cases only their collaboration in geological surveying was credited.[11]

Over the years, Teixeira managed to turn fieldwork training in the PGS into a 'school of geological fieldwork', becoming an extension of his own research school in the FSUL. Professors, students and researchers were responsible for many of the sheets of the Geological Map of Portugal, with the FSUL becoming linked to the making of geological mapping in Portugal. More and more graduates from the FSUL became geologists or scientific collaborators of the PGS and geologists from

[11] Primary sources: sheets of the 1:50,000 Geological Map of Portugal from 1959 to 1974 and corresponding memoirs.

the PGS, many of whom graduated from the FSUL, also began to teach in this institution. As a result, the school turned into a kind of 'private domain' of the FSUL, primarily due to Teixeira's influence inside the PGS.

Hence, the overall situation allowed for the improvement of the relationship between the FSUL and the PGS. Since the creation of the FSUL, almost all its professors of geology were also scientific collaborators of the PGS and one of them, Francisco Luís Pereira de Sousa (1870–1931), was even a professor in the FSUL and a geologist in the PGS at the same time. Notwithstanding, scientific collaboration between the two institutions became particularly fruitful after the 'school of geological fieldwork' was established.

In 1964, a reform of the faculties of science took place and a 5-year degree in Geology was established (Decree 1964). For the first time in Portugal, graduation in a scientific discipline assigned the corresponding professional title and graduates in Geology were recognised as geologists. The *curriculum* and course syllabuses were reorganised, trying to catch up with the latest developments in geology but keeping the previous structure: the first 2 years intended for general preparation and the remaining three for specialisation. The new legislation recognised that high-school teaching would continue to be the major professional occupation for graduates in Geology but it also acknowledged the need to give those same graduates a suitable preparation for other potential jobs. Courses of a more, let us say, 'applied nature' were created and implemented during the last 2 years of the degree in Geology: Ores and Geology of Ore Deposits, Fundamentals of Geophysics, Geological Mapping and Photogeology, Applied Geology and Geological, Geophysical and Geochemical Prospecting. Thinking of those students who sought to pursue a scientific career, the degree contemplated scientific seminars. The course on geological mapping was entirely practical and the geological fieldwork training in the PGS was part of it (Decree 1964).

However, the establishment of a 'school of geological fieldwork' in the PGS has some more deep and intricate contours: it can be perceived as a manoeuvre by members of the Portuguese geological community—with Teixeira in the lead—to place geologists in a scientific institution where their number was small and their role not properly acknowledged. Portuguese geologists had been criticizing the situation in the PGS for a long time, specially the power relations between mining engineers and geologists, with the latter being second in importance. From the geologists' point of view, engineers, especially mining engineers, occupied the place that should belong to them in a number of sectors of Portuguese society. Geologists saw the overall situation as representative of the lack of interest shown by the Portuguese State towards geology and its practitioners, which was held responsible for the 'devastating panorama' presented by geology in Portugal (Costa 1949). So, it is plausible to admit that the ever-increasing influence of Teixeira and his disciples inside the PGS was part of a strategy 'to colonize' the institution.

Concluding Remarks

Ideological differences between the liberal and republican regimes gave rise to different educational systems. The first was interested in preparing scientific and technical personnel to become part of the State corps and assist the construction of a modern nation; science was perceived as having most of all a propaedeutic utility. The second perceived science as something more; for the republicans, scientific disciplines had their own identity and inner value and in this context scientific teaching and research acquired a major and emblematical role. In spite of this, it is possible to recognize continuity between the PSL and the FSUL; after all, it was obviously difficult to build the latter almost from scratch. When the FSUL was created, buildings, equipment, students and professors were transferred from the PSL. The first inherited many features of the second; geology teaching was one of them.

It is clear that students did not get an adequate preparation in geology while attending the 7th course in the PSL: they learnt to describe and classify minerals, rocks and fossils and to solve exercises of geometric crystallography, according to a clearly natural-historical approach. Most students would become engineers but even to them the 7th course did not provide the required preparation and training, especially if they were meant to engage in future mineral exploitation.

The *curriculum* of the degree in Natural-Historical Sciences in the FSUL did not differ much: most courses devoted to the teaching of geological subjects were nothing more than the extension of subjects addressed in the 7th course. In fact, geology teaching at the FSUL continued to be envisaged as part of the general scientific preparation of future engineers and high-school teachers. Despite the good intentions of the republican regime concerning the study and practice of science, few people decided to pursue a scientific career, particularly in geology.

The new degree in Geological Sciences signalled a shift in geology teaching. The introduction of a more theoretical approach replaced the former generalist and anachronistic one characteristic of the degree in Natural-Historical Sciences. Some of the graduates in Geological Sciences embraced a career other than high-school teaching: they decided to be professors and researchers in the university. Changes in geological research at the FSUL took place. Until then, it rested mostly upon the study of museum collections; in the 1940s, it acquired a kind of 'laboratorial' character with the development of mineralogical and petrological studies. Nevertheless, the training and practice of geological fieldwork was still absent from geology teaching and research in the FSUL and high school teaching continued to be the future for most graduates in Geological Sciences.

The establishment of a 'school of geological fieldwork' in the PGS was crucial to overcoming this situation. If geology teaching in the universities was supposed to graduate geologists, fieldwork training should be part of it. Still, geological fieldwork can be quite expensive and time consuming and the FSUL did not have the required human and material resources to take up this venture. But the PGS had. Actually, it was the best-suited institution to train students in geological fieldwork at the time: it had a long tradition in geological surveying and mapping with scientific and technical staff—geologists and field assistants—entirely dedicated to this task.

The 'school of geological fieldwork' gave senior students from the FSUL the opportunity to get their first and basic training in geological fieldwork and mapping and it acted simultaneously as a kind of 'joint' venture between the PGS and the FSUL, allowing the tightening and strengthening of ties between the two institutions.

The introduction of fieldwork practice in the degrees of Geological Sciences and Geology at the FSUL endorsed students with the knowledge and skills that permitted them to search for other professional positions besides the 'usual' one: high school teaching. In fact, and with time, the number of geologists grew; some decided to pursue an academic career in Portuguese universities, others went to work in scientific public institutions where geological research was carried out. And after the creation by the Portuguese State of the professional title of geologist in 1964, some students found positions in the private sector, usually in mining and in the construction of infrastructure where their work had a more 'applied' character.

The 'school of geological fieldwork' also proved instrumental in pursuing the interests of the Portuguese geological community. Since the 1950s geologists had succeeded in taking up posts in scientific public institutions like the Council for Nuclear Power and the Council for Colonial Research. A few of them even occupied significant positions in the direction and counselling of those same institutions. This largely resulted from the lobbying of members of the geological community near the political power. Yet the PGS remained an exception: it continued to be reluctant in recognizing geologists in a rightful way. Thus, the school can be perceived as a way found by geologists to 'colonize' the institution and shift power relations by 'taking it from inside'. And they were quite successful in doing so.

In the end, it is possible to say that the introduction of fieldwork practice in geology teaching at the FSUL was also part of the process of assertion of the Portuguese geological community. As a result, the teaching and practice of geology in Portugal changed for good.

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References

Amador, Filomena. 2008. O Ensino da Geologia nas escolas portuguesas, durante o século XIX e a primeira metade do século XX: reformas curriculares e manuais escolares. *Terrae Didatica* 3:4–17.

Anonymous. 1857. *Programmas das Cadeiras da Escola Polytechnica no anno lectivo de 1856–1857*. Lisboa: Imprensa Nacional.

Anonymous. 1865. *Programmas das Cadeiras da Escola Polytechnica, anno lectivo de 1864–1865*. Lisboa: Imprensa Nacional.

Anonymous. 1916. *Programas e Horários*. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Anonymous. 1933–1934. *Programas e Horários*. Lisboa: Faculdade de Ciências da Universidade de Lisboa.

Antunes, Miguel Telles. 1989. Sobre a história do ensino da Geologia em Portugal. *Comunicações dos Serviços Geológicos de Portugal* 75:127–160.
Belhoste, Bruno. 2003. *La Formation d'une technocratie. L'École polytechnique et ses élèves de la Révolution au Second Empire*. Paris: Belin.
Bensaude-Vincent, Bernardette, José Ramon Bertomeu-Sanchez, and Antonio Garcia Belmar. 2004. Textbooks in the nineteenth century. A genre of scientific literature. *Chemical Heritage* 22:10–31.
Bertomeu-Sanchez, José Ramon, Antonio Garcia Belmar, A. Lundgren, and Manolis Patiniotis. 2006. Introduction: Scientific and technological textbooks in the European periphery. *Science and Education* 15:657–665. (Special Issue: Textbooks in the scientific periphery).
Butler, Robert. 2008. Teaching geoscience through fieldwork. *Geography, earth and environmental sciences learning and teaching guides*. Plymouth: University of Plymouth.
Carneiro, Ana. 2005. Outside government science, 'Not a single tiny bone to cheer Us Up!' The Geological Survey of Portugal (1857–1908), the involvement of common men, and the reaction of civil society to geological research. *Annals of Science* 2:141–204.
Carneiro, Ana, Maria Paula Diogo, and Ana Simões. 2006. Communicating the new chemistry in 18th-century Portugal: Seabra's Elementos de Chimica. *Science and Education* 15:671–692. (Special Issue: Textbooks in the scientific periphery).
Carneiro, Ana, and Vanda Leitão. 2009. Engineers, the geological survey of Portugal (1857–1908), and the professionalization of geologists. In *Jogos de Identidade: os engenheiros entre a formação e a acção*, eds. Ana Cardoso de Matos et al., 277–310. Lisboa: Edições Colibri.
Carolino, Luís Miguel. 2012. Measuring the heavens to rule the territory: Filipe Folque, the teaching of astronomy at the Lisbon Polytechnic School and the modernization of the State apparatus in nineteenth century Portugal. *Science and Education* 21:109–133.
Carvalho, Rómulo de. 1986. *A História do ensino em Portugal – desde a fundação da nacionalidade até ao fim do regime de Salazar-Caetano*. Lisboa: Fundação Calouste Gulbenkian.
Christie, J.R.R., and Jan Golinski. 1982. The spreading of the word: New directions in the historiography of chemistry 1600–1800. *History of Science* 20:235–266.
Corsi, Pietro. 2003. Which instruments for geological mapping? The case of the Italian geological survey. In *Musa Musei, studies on the history of scientific instruments and collections in honour of Mara Miniati*, eds. Marco Beretta et al., 433–442. Florence: Leo S. Olechki.
Costa, Amorim. 2000. As Ciências Naturais na reforma pombalina da Universidade, "Estudo de rapazes, não ostentação de príncipes". In *O Marquês de Pombal e a Universidade*, coord. Ana Cristina Araújo, 163–190. Coimbra: Imprensa da Universidade.
Costa, António Augusto de Oliveira Machado. 1937. *A VII cadeira e os seus professores*. Lisboa: Faculdade de Ciências de Lisboa.
Costa, João Carrington. 1949. Preâmbulo. *Boletim da Sociedade Geológica de Portugal* 8:1–7.
Ferreira, Martim Portugal. 1998. *200 Anos de Mineralogia e Arte de Minas: Desde a Faculdade de Filosofia (1772) até Ã Faculdade de Ciências e Tecnologia (1972)*. Coimbra: Faculdade de Ciências e Tecnologia da Universidade de Coimbra.
Freeman, M. 2001. Tracks to a new world: railway excavation and the extension of geological knowledge in the mid-nineteenth-century Britain. *British Journal for the History of Science* 34: 51–65.
Gaspar, Júlia. 2009. *A investigação no Laboratório de Física da Universidade de Lisboa (1929–1947)*. Lisboa: Centro Interuniversitário de História das Ciências e da Tecnologia.
Gonçalves, Francisco. 1976. *Carlos Teixeira. Notícia bio-bibliográfica. O Pedagogo, o cientista*. Lisboa: accessible author's edition.
Kaiser, David. 2005. Introduction: moving pedagogy from periphery to the center. In *Pedagogy and the practice of science. Historical and contemporary perspectives*, ed. David Kaiser, 1–8. Massachusetts: Massachusetts Institute of Technology.
Knell, Simon. 2000. *The culture of English geology, 1815–1851: A science revealed through its collecting*. Aldershot: Ashgate.
Kuhn, Thomas. 1962. *The structure of scientific revolutions*. Chicago: The University of Chicago Press.

McCartney, P. J. 1977. *Henry de la Beche, Observations on an observer*. Cardiff: Friends of the National Museum of Wales.
Mota, Teresa Salomé. 2008. Os manuais de Geologia do ensino liceal durante o *Estado Novo* (1947–1974). *Memórias e Notícias* 3:337–342. (Nova Série)
Mota, Teresa Salomé. 2011. A Geologia, esse 'lugar estranho': o caso da Escola Politécnica a da Faculdade de Ciências da Universidade de Lisboa. In *Livro de Actas do Congresso Luso-Brasileiro de História das Ciências*, coords Carlos Fiolhais, Carlota Simões and Décio Martins, 1106–1119. Coimbra: Faculdade de Ciências e Tecnologia da Universidade de Coimbra.
Oldroyd, David. 1990. *The Highlands controversy: Constructing geological knowledge trough fieldwork in nineteenth-century Britain*. Chicago: The University of Chicago Press.
Oldroyd, David. 1996. *Thinking about the earth, a history of ideas in geology*. London: Athlone.
Oldroyd, David, and Graham McKenna. 2005. Conditions of employment and work practices in the early years of the Geological Survey of Great Britain. *Earth Sciences History* 24:197–223.
Olesko, Kathryn. 1991. *Physics as a calling: Discipline and practice in the Konigsberg seminar for physics*. Ithaca: Cornell University Press.
Polanyi, Michael. 1958. *Personal knowledge, towards a post-critical philosophy*. Chicago: The University of Chicago Press.
Ribeiro, Orlando. 1958–1960. Ernest Fleury e o ensino da Geologia. *Boletim da Sociedade Geológica de Portugal* 13:303–308.
Ribeiro, Orlando. 1989. *Opúsculos geográficos*. Vol. I. Lisboa: Fundação Calouste Gulbenkian.
Rudwick, Martin. 1985. *The Great Devonian Controversy. The shaping of scientific knowledge among gentleman specialists*. London: The University of Chicago Press.
Rudwick, Martin. 2004. *The new science of geology: Studies in the earth sciences in the age of revolution*. Aldershot: Ashgate.
Rudwick, Martin. 2005. *Bursting the limits of time: The reconstruction of geohistory in the age of revolution*. Chicago: The University of Chicago Press.
Secord, James. 1986. The Geological Survey of Great Britain as a research school. *History of Science* 24:223–275.
Simões, Ana, Ana Carneiro, Maria Paula Diogo, Luís Miguel Carolino, and Teresa Salomé Mota. 2013. *Uma história da Faculdade de Ciências de Lisboa (1911–1974)*. With the collaboration of Ana Romão, Catarina Teixeira and Conceição Tavares. Lisboa: Faculdade de Ciências da Universidade de Lisboa.
Teixeira, Carlos. 1950. O que vale a Geologia. Missão do geólogo. Lisboa: accessible author's edition.
Teixeira, Carlos. 1956. A licenciatura em Ciências Geológicas. *Naturália* 6:21–27.
Teixeira, Carlos. 1967. *Panorama da Geologia no âmbito do ensino e da investigação científica*. Lisboa: accessible author's edition.
Torrens, Hugh. 2002. *The practice of British geology, 1750–1850*. Variorum Collected Studies Series. Aldershot: Ashgate.
Vetter, J. 2004. Science along the railroad: Expanding fieldwork in the US central west. *Annals of Science* 61:87–211.
Warwick, Andrew. 2004. *Masters of theory: Cambridge and the rise of mathematical physic*. Chicago: The University of Chicago Press.
Zbyszewski, Georges and Francisco Gonçalves. 1983. Carlos Teixeira. *Comunicações dos Serviços Geológicos de Portugal* 69:177–198.

Legislation

Decree 1837 published on 11 January (creation of the Polytechnic School).
Decree 1852 published on 31 December (creation of the course on Montanistics and Docimasy).
Decree 1856 published on 26 October (separation from the 7th course of the Principles of Metallurgy).

Decree 1868 published on 31 December (extinction of the course on Montanistics and Docimasy.
Decree 1890 published on 5 April (PSL transferred to the Ministry of Public Instruction and Fine Arts)
Decree 1898 published on 22 June (separation of Mineralogy and Geology in the 7th course).
Decree 1902 published on 3 October (new preparation for high school teachers).
Decree 1911a published on 24 March (creation of two new Portuguese universities in Lisbon and Oporto).
Decree 1911b published on 22 April (creation of the faculties of sciences in the three Portuguese universities of Coimbra, Lisbon and Oporto).
Decree 1911c published on 12 May (*curricula* of the degrees in the faculties of sciences).
Decree 1930 18:477 published on 17 Jun (reorganisation of the faculties of sciences).
Decree 1964 45 840 published on 31 July (reorganisation of the degrees of the faculties of sciences).

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Chapter 21
The Emergence of Biotypology in Brazilian Medicine: The Italian Model, Textbooks, and Discipline Building, 1930–1940

Ana Carolina Vimieiro Gomes

21.1 Introduction

> Who has been closely following, as I have, Prof. Rocha Vaz as for what he assumes to be a new science—Biotypology—disguised under the pompous name of Constitutional Science, will soon notice that all of his work is about the purpose of creating a chair for his own service, and for that only. (Barros 1936, p. 10)

In 1936, the Brazilian physician Abelardo Alves de Barros,[1] professor at the School of Pharmacy and Odontology of the State of Rio de Janeiro,[2] Brazil, published a critique of one of the arguments in the ongoing debates on the reform of medical education in Brazil that took place earlier in the 1930s (Barros 1936; Kemp and Edler 2004).[3] In his "Critical Study of Prof. Rocha Vaz's opuscle on Medical Education", Barros argued against the medical and theoretical concepts published by the physician Juvenil Rocha Vaz, titled "A New Ordering of the Medical Education". In that pamphlet, biotypology (the term for constitutional medicine that was widespread in Brazil) was described as a special field of knowledge and established as a foundation for clinical medicine.

Juvenil Rocha Vaz was a professor of Clinic Propedeutics at the School of Medicine in Rio de Janeiro. That school, along with the one in Bahia, was one of the

[1] It is worth noting that Abelardo Alves de Barros is known as an advocate in Brazil of the scientific ideas of Antoine Béchamp on microbiology—that is, the theory of microzymes.

[2] That school was created in 1912 and was located in the city of Niterói, the former capital of the State of Rio de Janeiro.

[3] In that period, the main schools of medicine in Brazil were located in Rio de Janeiro and Bahia (School of Medicine of Rio de Janeiro and School of Medicine of Bahia; São Paulo (School of Medicine and Surgery of São Paulo), Belo Horizonte (School of Medicine of Minas Gerais), Recife (School of Medicine of Recife), Porto Alegre (School of Medicine of Porto Alegre), and Ceará (School of Medicine of Ceará) http://www.dichistoriasaude.coc.fiocruz.br/iah/P/.

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first founded in Brazil at the beginning of the nineteenth century. From 1925 to 1926, Rocha Vaz was the director there.[4] It is important to note that there were no universities in Brazil until the 1920s. The University of Rio de Janeiro was created in 1920 by fusing the faculties of engineering, medicine, and law under the same administration (Schwartzman 2001). Only in 1931 under the provisional government of Getúlio Vargas was the first federal law established that regulated the attributes of Brazilian universities.[5] The University of São Paulo (USP) and the University of Brazil (formerly the University of Rio de Janeiro) were founded in that reformist context. In the context of medical training reforms in the schools of medicine at the universities, there were disputes over the best medical science model to be taught.[6] Among the disputes, German and North American medicine focused on the experimental model and the biomedical laboratory was opposed to the prevailing clinical tradition from France. As noted by Kemp and Edler (2004), when analyzing medical proposals for reforms, we must take into account the role of local medical communities in interpreting, selecting, and adapting models to Brazilian medical culture. Attempts to promote biotypology as a foundational scientific discipline for medicine and clinics, I argue, were an example of this creative reception and appropriation of a foreign theoretical model in discourses aimed at reforming medical training in Brazil.

The scientific content for the reform of medical training at the school of Rio de Janeiro proposed by Rocha Vaz received several criticisms. Among them, Abelardo A. de Barros said that Rocha Vaz's medical-theoretical conceptions of anatomy, pathology, and physiology were wrong, and he was skeptical of the so-called novelty in their teaching. His major criticism was aimed primarily at the notion of clinical medicine as a science of the individual—that is, a constitutional science. For Barros, there were two types of serious misunderstandings: first, concerning science—"no branch of science has an individual, rather than a collective, character because all science yields generalizations"; second, "the scope of clinical medicine is acting upon living organisms therefore it is an art rather than science". If science aimed to predict phenomena in the abstract, clinical medicine should aim to concretely modify living beings (Barros 1936, pp. 16–17). Barros stated sarcastically that in the School of Medicine, "if the Medical Course was organized according to his [Rocha Vaz's] odd ideas, it might become the pontificate to the followers of the 'science

[4] Rocha Vaz was also the director of the Departamento Nacional de Ensino (National Department for Education) do Ministério da Justiça e Negócios Interiores (Ministry of Justice). He was in charge of preparing a general reform of the Brazilian educational system, including higher education, implemented in January 1925 by decree 16.782A. The Clinic Propedeutics Chair was created through that reform within the new regulations for teaching medicine. Constitutional medicine was already part of the content of his teaching (Rocha Vaz 1929).

[5] The broad educational reform in higher education that organized Brazilian universities was called the "Francisco Campos Reform" and was established in the following decrees: 19.850, 19.851 e 19.852, April 11, 1931.

[6] For instance, North American models, through support from the Rockefeller Institute, influenced the scientific and institutional organization of the University of São Paulo, including medical training at the School of Medicine (Marinho 2001).

of constitution', while he himself might become the master of Clinical Medicine (…)" (Barros 1936, p. 8). Barros' writing conveys a reaction to the attempts by Prof. Juvenil Rocha Vaz and his group of physicians to provide scientific grounds for biotypology in the teaching of clinical medicine at the School of Medicine in Rio de Janeiro. This chapter aims to examine these attempts at discipline building by focusing on the physicians' discourses about the relevance of biotypology to Brazilian medicine.

This place for the field of biotypology was forged in Brazil through the circulation of knowledge and scientific practice in scientific textbooks.[7] Constitutional medicine had appeared in published material by Rocha Vaz since the late 1920s as one of the fields of knowledge that should guide the practice of medical semiology. In his textbook, in the lessons for his course 'Clinic Propaedeutics', Rocha Vaz gave a nod to the uses of this field of medicine. His interest was in understanding, in terms of "normal morphological types", the normal body references revealed through "the set of morphological characters in the trunk and belly in which variations in form, position and tonus of certain organs were related" (Rocha Vaz 1929, p. 25). It was not until 1932 that Rocha Vaz published the textbook entitled "*Novos Rumos da Medicina*" (New Directions in Medicine). The book brought together medical, scientific, and institutional models of constitutional medicine originating in foreign countries to serve as the grounds for his plan for theoretical and practical clinical medical training. He noted, "today the issues in clinic require a systematic study of the constitution and personality of the diseased, as well as the grounds for the understanding thereof" (Rocha Vaz 1932, p. 17). Rocha Vaz claimed (1932, p. 18) that among the medical doctrines, the study of "individual constitution, a field of important thought since the ancient times, gathered a patrimony of practical knowledge over the foundation of scientific and systematic methods, having unlimited medical and social applications".

Abelardo Barros's criticism indicates that Juvenil Rocha Vaz inspired followers in his effort to make biotypology a medical doctrine in Brazil. Several of his followers published textbooks systematizing knowledge in that field (Berardinelli 1933; Peregrino Jr. 1940; Ramalho 1940; Rocha Vaz 1932; Berardinelli and Mendonça 1933) or books announcing the results of scientific examinations of the biotypological features of Brazilian individuals (Brown 1934; Ferraz and Andrade 1939). Some of these were dedicated to "Rocha Vaz, our master", to whom the pioneering of biotypology in Brazil was then ascribed. The textbooks served to train physicians in the application of biotypology in various areas, including clinical medicine, physical education, educational projects, and criminology.[8]

[7] The present chapter uses as its main sources four textbooks on biotypology published in Brazil in the 1930s and early 1940s. These books envisaged different audiences in medicine: clinical medicine, Novos Rumos da Medicina by Rocha Vaz and Noções de Biotipologia: Constituição, Temperamento, Caracter, by Berardinelli; education, Biotipologia Pedagógica, by Peregrino Júnior; and physical education, Lições de Biometria Aplicada, by Sette Ramalho.

[8] The Instituto de Identificação (Identification Institute) of Rio de Janeiro was founded in 1933 under the direction of the physician Leonídio Ribeiro. It held a Laboratory of Criminal Biotypology. Prof. Rocha Vaz's assisting students worked at the Institute. São Paulo also had a center for

Among Rocha Vaz's followers, the physician Waldemar Berardinelli, then assistant professor of clinical medicine at the School of Medicine in Rio de Janeiro, published the majority of the textbooks for the promulgation of biotypological knowledge. In the 1930s and 1940s, he published five books, two of which, in 1932 and 1933, shared the same title: *Noções de Biotypologia: Constituição, Temperamento, Caracter*" (*Notions of Biotypology. Constitution, Temper, Character*). In 1936, he published another, titled *Biotypologia: Constituição, Temperamento, Caracter*" (*Biotypology: Constitution, Temper, Character*). In 1942, he published *Tratado de Biotipologia e Patologia Constitucional* (*Treatise of Biotypology and Constitutional Pathology*), and in 1933, he co-authored the book *Biotipologia Criminal* (*Criminal Biotypology*) with João L. de Mendonça, a physician at the School of Medicine of Bahia.

These textbooks provide evidence for the esoteric and exoteric aspects (Fleck 1981; Vicedo 2012) of the emergence of biotypology in Brazil. Furthermore, they provide the concepts, models, assumptions, authors, techniques for body measurements, classification parameters, and scientific institutions, both local and foreign, that inform the practice of biotypology in Brazil. From their titles, tables of contents, and the arrangement of their content, we can infer the audience the authors envisaged, which comprised, above all, physicians and students of medicine. The textbook dedications, those who signed their forewords, and their publishers reflect heterogeneous actors and social networks connected to the enterprise of constitutional medicine in Brazil. All of these elements, in relation to each other, reflect the ideological, political, and social issues underlying the interest in forging biotypological studies in the country. The sequence of published textbooks from the 1930s to 1940s leads us to consider them a privileged locus for understanding the initiatives by some Brazilian physicians to promote biotypology as a medical-scientific field in Brazil.

This chapter refers to historical studies on efforts to define disciplinary boundaries within the medical field and addresses the emergence of biotypology in the Brazilian biomedical scientific agenda of the mid-twentieth century (1930–1940), in the context of reforms of university policy and medical education. I examine Brazilian textbooks in this field and explore the influence of Italian constitutional medicine on that emergence. The analysis of the accommodation of knowledge through textbooks sheds light on the circulation of foreign biotypological models in Brazil and its creative reception and local appropriation according to Brazilian scientific culture and medical interests. This chapter also provides evidence of the circumstances in which textbooks transformed original scientific knowledge, revealing the role of scientific approaches in the process of developing biotypology as a fundamental discipline in medical practices (Gavroglu et al. 2008; Olesko 2006; Bertomeu-Sanchez et al. 2006; Carneiro and Simões 2006). The analysis calls attention to attempts to validate biotypological practices as a way to endow clinical and medical training in Brazil with a specific type of scientific status and way of knowing. This analysis demonstrates the relationship between biotypology and the

biotypological studies in criminology. On the attending practice of biotypology at the criminal institutes in Rio de Janeiro and São Paulo, see Cunha (2002) and Ferla (2009).

debates over race and national identity that occurred in Brazil in the 1930s as another way of legitimizing the relevance of biotypology in the local scientific agenda of medicine. Finally, this chapter investigates the uses of biotypology in various medical practices as a way to predict diseases and define patterns of normality in the bodies of Brazilian individuals.

21.2 Foundation of Biotypology in Brazil: The Influence of the Italian School

21.2.1 Contextual Issues in the Emergence of Biotypology

Biotypology emerged in Brazil in the political, social, and cultural setting of markedly nationalistic concepts, the circulation of fascist ideas, and debates on race and national identity. Within medicine, the sub-disciplines of microbiology and hygiene had already been affirmed as the main fields guiding physicians' actions toward national health, given the visibility and success of the bacteriological institutes founded in the country since the early twentieth century. Biotypology was promoted during this period of change in medical training underpinned by higher education reforms in the country. These contextual features shaped the scientific meanings, aims, and practices of biotypology in Brazil, which focused on biological individuality and on classifying and grouping individuals to compare the similarities in their biological traits.

Since the 1920s, there has been an ongoing debate in Brazil on the ethnic, social, and cultural characteristics that could be defined as typical, native, and national (Hershman and Pereira 1994; Leite 1976; Ortiz 1985; Skidmore 1998; Weffort 2006). Changes in society in those years that resulted from social life in modernity and political-economic frameworks in the country demanded new ideas and categories for understanding and interpreting Brazil through factors that were specific to the nation. In this set of ideas, it was necessary to break from older explanatory systems because these—many of which were of foreign origin—no longer supported a new Brazilian reality. Views arising from these debates stressed the social reality of Brazil in its own locale. This time was marked by strong nationalist overtones that increased with the establishment of the 'Estado Novo' (New Government) under the government of the president Getúlio Vargas.

Among the political projects aimed at understanding and affirming "what was national", one of the most frequently discussed aspects among Brazilian intellectuals was race, or Brazilian racial or ethnic identity. There was an increasing refusal of the negative aspects of racial and ethnic classifications in the fields of medicine and anthropology, leading to the idea that miscegenation would yield regeneration, not degeneration (Schwarcz 1993; Stepan 1991). Miscegenation was considered a fundamental aspect of the definition of a desired 'national character,' which was to be white on some occasions and mixed, both biologically and culturally, on other occasions.

In this context, a socio-constructivist historiography of Brazilian science stressed the role of eugenics in scientific discourses and social debates as an instrument to solve Brazilian social issues and to determine the future of the nation. This discussion focused on preventive eugenics, which was grounded in racialist ideology but subtly distanced itself from extreme open racism (Stepan 1991).[9] In Brazil at that time, eugenics was associated or even equated with hygiene. Embedded in microbiological foundations and through social and environmental interventions, hygiene became the grounds for the idea of regeneration. Eugenic practices were close to hygiene and focused on sanitation and education because the Brazilian people were considered sick, not degenerate. Studies showed that until the 1920s Brazilian eugenics was grounded in neo-Lamarckism more than Mendelism. The emphasis on neo-Lamarckism did not indicate a lack of racialism or racism. Several Mendelians in Brazil claimed a less negative racialist-oriented eugenics than neo-Lamarckists by proposing, for example, that individuals should be instructed on the importance of heredity (Stepan 1991).

Some sociological analysis was oriented toward the cultural bases that were at stake. This was the case with the book *Casa Grande e Senzala* (*The Master and the Slaves*, 1934), published by a student of Franz Boas (at Columbian University), Gilberto Freyre. The analysis proposed by Freyre suggested the idea of a typical racial harmony in Brazil resulting from cultural and biological mixing, the so-called 'Myth of Racial Democracy'. Racialist and racist perspectives remained. In the Estado Novo, debates over eugenics were mobilized to ground government policies for scientifically restricting immigration (Ramos 2008). Biotypology played a role in these debates and was proposed as a field of knowledge that had an alternative view of but was not incompatible with, the racial categorization of individuals (Cunha 2002). As Berardinelli emphasizes (1942, p. 327), it was for investigators "to check which 'types of constitution' were held by each of these 'types of races' and with what frequency".

21.2.2 The Origins of Biotypology

> It is the science of the human type with all of its characteristic living manifestations, the science, we can say it, of the 'individual biotype'. (Pende 1925, p. 5)

By analyzing the meanings proposed for biotypology in Brazil, we can see that it was constitutional medicine given a new outlook and framed according to the medical and scientific interests of Brazilian biomedical science in the 1930s. In the biotypological textbooks, the most frequently acknowledged meaning of biotypology

[9] It is important to consider the ambivalence of racialism and racism in Brazilian eugenic thinking in the 1920s and 1930s. The Brazilian elite was racist and racialist in its idealization of whiteness in the "whitening myth" (the idea that by mixing races, the population would be mostly white). At the same time, racial thinking was not prone to extreme racialism but to social and ideological reasoning. There was an optimistic racial interpretation and a positive view of miscegenation in which the mulatto and Negro could contribute to Brazilian cultural and social life (Stepan 1991).

was that proposed by the Italian physician Nicola Pende (Berardinelli 1933, 1936), in which the word meant the “science of constitutions, temperaments and characters”. In these terms, as noted by Peregrino Júnior (1940, p. 3), biotypology also referred to “shapes, tendencies, impulses, vocations…”. It represented “the scientific stage of constitutionalist doctrine” as it combined experimental science and the study of the human constitution. Another explanation indicated the novelty of biotypological approaches, suggesting that they were “the transition from constitutional doctrines, from empiricism, towards science” (Berardinelli 1936, p. 15).

The intended meanings were often followed by the word ‘science’, bringing a new and supposedly scientific outlook to traditional constitutional medicine. The field was often called ‘constitutional science’. Another important definition was connected to the epistemological approach of medical practice, the gaze at the individual. As Berardinelli noted (1936, p. 8, 281), it was also called “the science of the human individuality”, “the science of the personality”, “the science of the individual difference”, “comparative biology of human beings”, and the “study of the differential biology of the individual”. It was also “the science of the architecture and engineering of the individual human body” (Peregrino Jr. 1940, p. 3). This variety of meanings was not without problems. “The words were various and rarely accurate or precise”, as Peregrino Júnior observed (1940, p. 6), and the terminology became “even more confusing, controversial and to some extent incongruous”. Such polysemy reveals the attempts by Brazilian physicians to establish proper ways of knowing, scientific status, and the boundaries of their subject.

Regarding its scientific practices, constitutional medicine within the biotypological framework followed the procedures of morphological, physiological, and psychological measurements. To some extent, its techniques were closer to those in anthropometry. The individual constitution was the synthesis of all of the biological features of an individual, sometimes considered to be influenced by heredity. Classifications of human bodily features, which were called biotypes, were developed from mathematical and sometimes statistical treatments of all bodily quantifications. Each pattern of classification had its own set of definitions and names for the different biotypes. It was suggested that every individual should be considered, and people should be gathered into groups according to their typologies. To the physicians promoting biotypology in Brazil, determining types was a path to understanding individual features. Grouping people into biotypes was a procedure aimed at normalizing the bodies of the Brazilian people.

Biotypology was often mixed with anthropology (Albrizio 2007). Physicians admitted that biotypology was based on scientific practices and was a specific division of that field. The textbooks attempted to distinguish anthropology from biotypology. It was argued that biotypology was interested in the analysis of the “very particular features of each individual case”, whereas anthropology “was attentive to the general features of the races”, proceeding with a synthesis of the general features of the world population (Berardinelli 1942, p. 316). This differentiation maintained a dialogue with notions from the Italian School regarding the meaning of biotypology. As Pende noted, “this field of human knowledge comes from the scientific knowledge of somatic-psychic individuality, that is, from the science of the individual concretely as opposed to that abstract species of the human spirit that is both synthetic and ordering" (Pende 1925, p. 5). Although both fields rejected the classification of individuals, biotypologists considered the two fields opposed in their purposes: one aimed at generalization and the other at particularization.

21.2.3 Local Appropriations of Italian Models for Bodily Classification

The models for the classification of people's constitution that were quoted most frequently in Brazilian textbooks were those from France, Germany, and Italy. The French models discussed the classifications proposed by Claude Sigaud (1862–1921), who identified four human types from morphological and physiological data: respiratory, digestive, muscular, and cerebral. The published debates that occurred at the *Societé de Biotipologie* related to the *Conservatoire des Arts et Métiers in Paris* and were often referred to when justifying the practice of biotypology in Brazil. Some Brazilian biotypologists, including Leonídio Ribeiro and Waldemar Berardinelli, were members of the society, and their works were cited in its bulletin.

Several physicians from Germany who were dedicated to constitutional medicine were also quoted in the Brazilian textbooks, including Benecke, Brugsch, Grote, Tandler, and Bauer. Information on the last of these physicians is found in the textbooks in connection with his concept of "body complexion", which resulted from a blend of "condition (acquired characteristics)" and "constitution (inherited characteristics)", thereby shaping individual personalities (Peregrino Jr. 1940, p. 8). However, the model and classification procedure were produced by the German physician Ernst Kretschmer, who proposed three divisions by relating temperaments and psychological conditions to morphological features: pyknic, lepsome, and athletic types.

The Italian School was the most frequently practiced model in Brazil. There is evidence that Brazilian and Italian biotypology were connected; among the physicians practicing biotypology in Brazil, two, Waldemar Berardinelli and Leonídio Ribeiro, were given the Lombroso award in Turin in 1933. This yearly award was given to students of Criminal Anthropology who were distinguished for their discussion of Lambrosian ideas, especially the ones on the relations between biological features and psychological and social behavior of (non)criminals. As emphasized by Mario Carrára (who succeeded Lombroso in the Criminological School in Turin), the two Brazilian physicians knew how "to display lucidly and accurately the informative criterion for modern biotypology" (Berardinelli 1942, p. 8). Three editions of the textbook by Waldemar Berardinelli contain short prefaces in which the Italian physicians praise the publication. Mario Barbára's words in one of these prefaces describe the book's contribution to constitutional medicine: "the book summarizes quite clearly the whole bulk of the doctrine having no equal in Italy, a translation thereof into our language would be most welcome" (Berardinelli 1942, p. 8).

In some of the Brazilian textbooks, Italian constitutional medicine was legitimized based on discourses on its evolution. Its origins could be found in Hippocratic views on humors that evolved over time and that were re-signified and radicalized in the new setting as well as other countries. As Berardinelli (1942, p. 33) put it, "Intuitively and empirically the Human spirit because the oldest Oriental civilizations [passed down through the Greek] attempted to group individuals according to their similarities". By the end of the nineteenth century and the first decades of the twentieth, the physician De Giovanni vehemently argued for constitutionalist principles of the individuality of the diseased through the Italian School. It was then that "the definite transposition from empiricism to science" occurred by means of Giacinto Viola's conceptions (Berardinelli 1942, p. 44, Rocha Vaz 1932, p. 14).

The names Nicola Pende, Giacinto Viola, and Mario Barbàra were most often cited among the members of the Italian school in the most important Brazilian textbooks (Berardinelli 1933; Peregrino Jr. 1940; Rocha Vaz 1932; Ramalho 1940). Viola, to mention one example, was considered the 'father' of Italian constitutional medicine in its scientific phase. The main classification pattern proposed by Viola, based on morphological data, was normotypes (people with symmetrical proportions of limbs, abdomen, chest, and trunk) and the two variations, brachytypes (with the trunk larger than the limbs and the abdomen larger than the chest) and lankytypes (with the limbs larger than the trunk and the chest larger than the abdomen). The terminology was developed using mathematical proportions of the trunk, limbs, and abdominal regions. The body was understood through two vital systems: "vegetative life", encompassing the viscera in the trunk, and the "life of relationship", corresponding to the limbs (Brown 1934, p. 69). Evidence shows that the instruments and methods for body measurements and classifications that were often conducted in Brazilian studies on biotypology were those proposed by Viola (Ramalho 1940; Peregrino Jr. 1940; Berardinelli 1936, 1942).

Mario Barbára followed and updated Viola's classifications and added eight groups. Waldemar Berardinelli modified Barbàra's model by proposing new terminology and groupings. This new configuration was called 'Barbàra-Berardinelli's classification'. After proposing new mathematical proportions for the limbs, trunk, and abdomen, Barbára added the prefixes macro- and micro- to the biotype names and applied the Greek words *cormus* and *melos* for the chest and limbs, stating that the main benefit of this new classification was the possibility of "including Barbàra types in the general law of binomial distribution"; he was reconciling Barbàra models and Viola's statistical approach (Berardinelli 1936). Some investigations into the biotypological profile of Brazilians utilized the Barbàra-Berardinelli classification (Brown 1934; Ferraz and Andrade Jr. 1939).

Nicola Pende was also known in Brazil for his classifications of women: maternal lankytype, maternal brachytype, post-puberty or prematernal, hypo-developed, and prepuberty (Berardinelli 1936, p. 295). The theoretical foundation of the classification related women's fecundity and hormones to morphological phenotypes. As Rocha-Vaz stated (1940, p. 3), the study of the biotypology of women was crucial because it is women "who take most of the toll from the functional derangement of the endocrine glands which devoid them of harmony in their lines, making room for

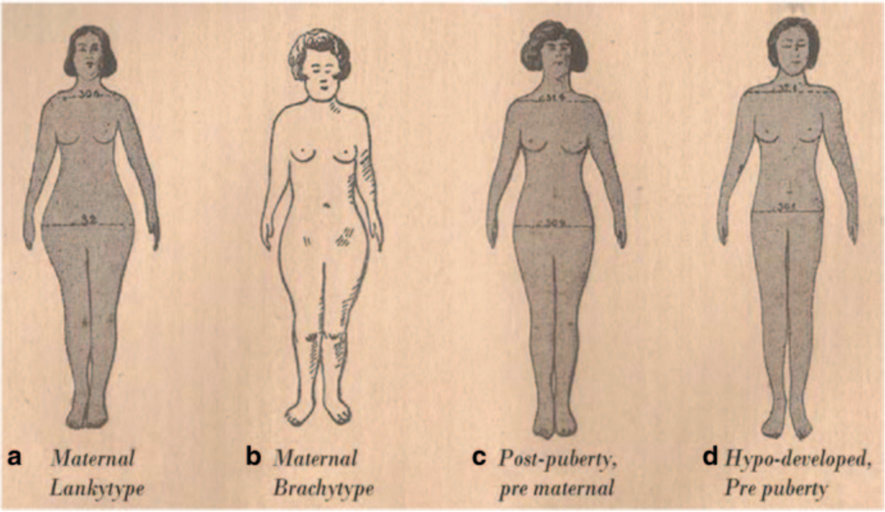

Fig. 21.1 Female biotypes according to Nicola Pende. (Reproduced from Berardinelli 1942, p. 345)

the constitutional disorders, and changing their intellectual-affective personality". The figure depicts a representation of the female types according to Nicola Pende as presented in Berardinelli's textbook (Berardinelli 1942, p. 345). This type of figure could be considered a guideline for bodily classifications. (Fig. 21.1)

Pende was acknowledged as the main advocate of the theoretical grounds, applications, and benefits of the practice of constitutional medicine as well as his initiatives in the creation and leadership of the institute of biotypology in Genoa (Biotypological and Orthogenic Institute) (Barbára and Vidoni 1933). The Institute was cited as a model to be followed by the Brazilian authorities. Juvenil Rocha Vaz (1932, p. 178) even proposed the creation of such an institute in Brazil, the 'Modern Institute for the Biology of the Individuality'. Although accepted among some of his peers at the University of Brazil for its relevance and social-medical applications,[10] the initiative was soon aborted by the Minister of Education and Public Health, Francisco Campos (Rocha Vaz 1932, p. 179). This action demonstrates the lack of political alliances for the institutionalization of biotypology in Brazil or its success as a scientific field to serve as a foundation for the government's project to control the bodies of the Brazilian population.

[10] Biotypology (and orthogeny) was deemed one of the specialization courses to be taught at School of Medicine of Rio de Janeiro (Regimento Interno da Faculdade de Medicina do Rio de Janeiro 1932).

21.3 Scientific and Social Relevance of Biotypology to Brazilian Medicine

21.3.1 Theoretical Grounds of Biotypology

Brazilian physicians attempted to maintain the significance of the practice of biotypology in Brazil in a twofold manner: epistemologically/theoretically in terms of the medical-scientific aspects underlying the field, and virtually in terms of its various medical-political-social applications. According to Peregrino-Júnior (1940, p. VIII), because of these aspects, there was justification and acknowledgement of the need for "coordinating and leading studies for determining the relationship of the various [biological] human traits and the scientific classification of the individual types".

The most important epistemological basis advocated by biotypologists to legitimize the field, according to the Italian School, was the unitary notion of the body in health or illness (Rocha Vaz 1932, p. 16). As Juvenil Rocha Vaz (1932, p. 17) noted, the definition of health and illness must be based on the "unitary concept of the human organism" by privileging the analysis of the whole body, beginning with its individuality. The body was understood as a whole, with a relation between its various parts and functions. There was a holistic view of the body related to this idea of a unity.[11] Medical holism is historically characterized by its focus on the individual as well as the environment or population; the organism was treated in a systematic way by privileging its general state rather than the organs by themselves. The parts were sometimes considered to be interconnected, or the whole was perceived as determining the actions of the parts. Illness was defined as a general disorder of the whole body, regardless of evidence of local lesions or etiological agents. People's tendencies and experiences of health and illness were considered unique and even inherited (Lawrence and Weisz 1998, pp. 2–3). As Peregrino Júnior (1940, p. VII) argued, "the human individual is a psycho-somatic and indivisible unity"; consequently, its understanding depends on "severe unitary and correlative criteria" in an attempt to find "the delicate and complex organic harmony".

This holistic view of the body was often represented in Brazilian textbooks through the image of a pyramid or a tetrahedron (considered to be a perfect geometric form). The choice of image was based on the model for determining the individual, as proposed by Nicola Pende. According to Pende, heredity (genotypic or phenotypical) was at the base of the pyramid as an important element to explain individuality. Each of the three sides corresponded to the biological features of a person: morphological, physiological, and psychological. The summit of the pyramid was the meeting point of all of its sides, representing the synthesis of the various body parts that constitute the vital properties of each person. It was not the

[11] According to Lawrence and Weisz (1998), holism was a term the most commonly acknowledged definition of which carries a rhetorical claim in opposition to approaches viewed as "narrow and reductionist in focus".

mere sum of the features of each function or organ but rather the outcome or the reciprocal coordination of all parts (Berardinelli 1936, pp. 73–74).

The promoters of biotypology in Brazil, which was based on the Italian School's approaches, opposed reductionist medical practice that focused on illnesses or local organic structures. By advocating constitutional medicine, physicians proposed a medical practice that focused on the *terrain*, the sick, or the particularities of each person. Disease-related entities were connected to endogenous factors. According to Juvenil Rocha Vaz (1932, p. 14), in any clinical case or practice "Today we have been habituated in considering the individuality of the diseased as the most important among the several unknown issues that medical thought ought to face". According to Rocha Vaz (1932, p. 125), "the modern physician can no longer conceive of a diagnosis and treatment from the organs and organic systems, he has to leave behind the localistic orientation towards considering death-related entities or nosologic species as a casual and criterion of co-relations".

This idea was in agreement with Giacinto Viola's assumption of the need for a special approach in dealing with the individual: "If individuality is unique, the science to study it should also be unique. And if the approach needs to be reconstructive and synthetic, the clinics, the great mother of medicine come back to it honorably" (Viola 1926, p. 10). According to Berardinelli (1936, p. 7), the following issue was posed to Brazilian medicine: "Why are individual biological differences not taken into account?" A scientific basis was lacking in the observation of individuals. By following biotypology, or the science of constitutions, "the individual diversities also obey strict conditions and fixed laws" (Berardinelli 1933, p. 32). To achieve this goal, the physician needed numbers and quantification. On this point, Berardinelli (1936, pp. 23–25) followed Giacinto Viola's approaches by maintaining that "individuality never repeats, but the numbers, measurements, statistical relations enable defining the individuals, determining their place in a sequence, and because there are similarities within the differences, it is possible to classify them according to these similarities".

Biotypology in Brazil was sometimes connected to initiatives of normalization. It was proposed that through statistical analysis the biological normality could be attained (Canguilhem 1989; Hacking 1990, 2007). This was another approach utilized according to Italian constitutional medicine and the German constitutional doctrine. In the German constitutionalist doctrine of the 1920s and 1930s, debates among physicians such as Brugsch, Bauer, Günter, and others regarding human variability were gradually associated with defined norms, albeit beyond subjective interpretations. Statistical-mathematical methods were applied to express variability and define human types in an effort to establish a statistical conception of normality (Vácha 1985).

Biotypologists in Brazil, quoting Giacinto Viola, accepted the idea that "constitutional variations follow the law of errors proposed by Quetelet-Gauss" (Berardinelli 1936, p. 25). As asserted by Rocha Vaz, "individual variations, whether somatic or functional, have laws that are governed by mathematical-statistical exact principles with highest scientific value" (Rocha Vaz 1932, p. 47). Mode, mean, median, and standard deviations were all statistical concepts used to define the criteria for normality. From the statistical point of view, Berardinelli (1936, p. 52) said, "Normal individuals are those whose measurements match the central values for the ethnical groups to which they belong". Normal people were seen as "those whose characters are similar or very near to those of individuals making up the maximum ordinate axis in the curve of frequency" (Berardinelli 1936, p. 52). The more a person "moves away from the established average normal type, the more severe is their deviation" (Berardinelli 1936, pp. 65–69). It was possible to find people whose body measurements matched the measurements of a large number of individuals. These were the *real average types* who presented morphological harmony and no extreme corporal measurement.

These statistical analyses of anthropometric features were deemed by biotypologists to be useful only for politicians, public managers, sociologists, military personnel, pedagogues, and educators. From the particular facts, they derived an idea of the whole that guided their activities and interventions in the population. Clinical interests were quite the opposite: to apply the general laws of pathology in concrete clinical cases because what was of interest to the clinic was individuals themselves. In fact, biotypologists said that individualization excluded normality as understood in statistical terms. The idea of normality could only be "a tool for the soul aiding the apprehension of the endless individual variation" (Berardinelli 1936, pp. 67–68).

Instead of talking in terms of mere normality, Brazilian biotypologists, in dialogue with a German physician called Grote, proposed approaching the body by means of its *responsiveness* or *personal normality*, which meant the body responded according to individuals' biological needs. "A *responsive* individual was one whose psycho-somatic complex works optimally, or at least well, according to their own biological and social needs" (Berardinelli 1933, p. 72). According to this idea, the individual was responsible for his or her own pattern of normality. Each individual had "his own health, regardless of the quantity or quality of his variations in relation to average and normal types". Here, we have a distinction in the norms of biological and medical thinking. The former requires the concept of type to grasp the differences and statistical arrangements of biological features as a way of assessing normality. The latter envisions the uniqueness of the individual and distinguishes states of health and disease from the personal normality of the individual (Vácha 1985). This concept was rejected by the Italian School, which proposed instead statistical normality and the concept of the "average type" (Berardinelli 1936, p. 66). Similar to constitutional medicine in the US context (Tracy 1992), the promotion of biotypology in Brazilian medicine was not limited to a reaction against reductionist medicine. It was encouraged by several scientific agendas, such as the one concerning the racial debate.

21.3.2 The Debate on Race in Biotypology

Individuation discourses are ambivalent about the idea of determining biotypes because grouping individuals according to type implies the selection, normalization, and standardization of desirable and undesirable physical shapes, mental and moral qualities, observed biological features, and ideal body types. Biotypology is another way to model identity and human groups and to mark differences and hierarchies among individual bodies, thereby involving biased conceptions of what an ideal type might be. Biotypology can also be applied in the justification of inequality (Lipphardt 2009; Gould 1996). In a country such as Brazil, with a history distinguished by unequal social dynamics, it is interesting to note the association between biotypology and the debates over national identity and racial miscegenation that occurred in the 1930s and 1940s.

The present chapter argues that the determination of race was not the main focus of the biotypology practiced in Brazil. The relation between race and constitution was often emphasized in textbooks in this field. We can see that this field was embedded in concepts and practices that originated in anthropology. This was another strategy to legitimize the relevance of the field in the Brazilian biomedical scientific agenda in the context of debates over national identity within the medical, scientific, and social thinking realms.

According to Brazilian physicians, who drew upon the debates that originated in Italian constitutional medicine, this association between race and biotypes was not self-evident or consensual. Physicians from the Italian school were opposed to it. According to Viola's reasoning, the two opposing definitions he proposed, brachytype and lankytype, were universal and could be found in all races. Although biotypological reasoning in Viola's thinking was not centered on racial or ethnical determination, evidence shows that some racialist approaches merged with the practice of biotypology in Brazil, mainly by indicating skin color and/or the nasal index. Race was one of the biological features that was analyzed and often employed to locate and group physical types according to the established ethnic features of Brazilians proposed by anthropologists, such as Roquette-Pinto (Souza 2008). Berardinelli (1936, p. 280) noted that "the study of the constitutional types was not incompatible with research on ethnical groups" because race and constitution were complementary.

In his empirical study on the Brazilian normotype, the physician Isaac Brown, a disciple of both Rocha Vaz and Berardinelli, stated that he had not dismissed "the possible predominance of some individual types in some races" (Brown 1934, p. 199). For him, this could be justified in terms of the biological specificity of each ethnic group. Individuals should be compared to their own group. Other biotypologists, like Stoffel (1937), drawing on environmental and cultural knowledge to explain the diversity of human biology, assumed that differences were due to the 'degrees of civilization'. Alvaro Ferraz and Andrade Júnior (1939), in this same reasoning, stated that the (social) environment could have a long-term effect on individuals' physical frame, shaping features that are shared by all individuals who are similarly influenced. Here, we can identify an optimistic assumption about the possibility of establishing a particular and homogeneous bodily identity and typology for Brazilians.

21.3.3 Applications of Biotypology in Medicine

> Human Biotypology is above all of interest to hygiene, medicine, social medicine; it is of interest to the educator, the anthropologist and the biologist who are curious about issues of heredity and race improvement. It is of interest to criminalist philanthropy claiming that the immoral should be re-habilitated as well as those prone to crimes; it is of interest to the philosopher for its approach on the everlasting issue of the relationship between physical personality and psychic personality; it is at last of interest to the political man and the leader of the people towards establishing a new politics which we can call biological politics, or psychosociology, or biosociology. (Pende 1925, p. 6)

Brazilian physicians attempted to gain visibility for the assumptions and content of biotypology by designing it in the light of theoretical and practical interests in medical action. This process did not only occur within medical clinics. Biotypology was considered medical content suitable for education, criminology, physical education, and sports as well as for professional guidance and organization in industries (Rocha Vaz 1932; Berardinelli 1936; Peregrino Jr. 1940; Ramalho 1940).

In clinics, biotypology was deemed useful for guiding diagnostic and therapeutic practices due to its ‘unitary and correlated’ conceptions of the body. According to Rocha Vaz (1932, p. 126), semiology was needed along with a painstaking clinical analysis, “a logical synthesis with unitary, polyedric (sic) and fair assessment and interpretation of all the morbid state together with the personality of the diseased”. The knowledge obtained from biotypology was indispensable for examining internal organs and for understanding the predisposition to local illness. This was the source of its renewed contribution to the analysis of classical semiology, which, until then, had not “[taken] into consideration individual differences” and sometimes yielded the wrong diagnosis. This was the case with the digestive system, where “the lower part of the stomach in the asthenic is viewed, in many of them, with gastric ptosis” (abnormal displacement of the stomach) (Berardinelli 1936, p. 314).

Biotypological classifications helped to determine morbid predispositions. Different biotypes conforming to bodies were associated with the likelihood of developing particular diseases. In the case of the brachytype person, arthritis, obesity, rheumatic aches, gout, glycosuria, diabetes, nephritis, calculosis, seborrhea, and hypertension were among the diseases mentioned. The lankytype person was inclined to develop anxiety, neurasthenia, anemic conditions, and acute infection of the lungs, such as tuberculosis (Berardinelli 1936, pp. 317–318).

Within medical practice, the usefulness of biotypology was connected to auxology (science of human physical development chiefly in terms of the phenomena of growing from infancy to adult life) and surgery, where “determining external morphology and its visceral correspondence yields the exact location of the field where to operate” (Rocha Vaz 1932, p. 132). The study of individuals contributed to the likelihood of success in surgical interventions (Berardinelli 1936, p. 323; Rocha Vaz 1932; pp. 130–132). Specific diseases were also associated with biotypes. One hypothesis, following Giacinto Viola, was that cancer occurred more often in average normal types. Infectious diseases, such as tuberculosis, were understood as not restricted to a microbial origin but rather as involving a "constitutional reaction because the same type of microbe produces several infections in different individuals" (Berardinelli 1936, pp. 345–349). Associations among constitutionalist conceptions and pathological elements encompassed aspects of various organic systems as well, including the neuropsychiatric, ophthalmologic, dermatologic, urinary, circulatory, respiratory, and digestive systems.

Another significant link was between biotypology and endocrinology. A relationship was proposed between the mutual influence among anomalies and hormonal dysfunctions and ethical-moral aspects; the constitutional condition was considered to determine the definition of the criminal character (Rocha Vaz 1932, p. 146). In a textbook for an audience beyond physicians, Rocha Vaz (1940) suggested that 'functional disorders' at the level of the hormones in women paved the 'way for the constitutional disturbances'. He said that the teachings in his book should aid women in understanding 'the cause of her physical and psychical disharmony'; 'The features of [the] female bodily shape depended on the endocrinal system', whether it was in balance (i.e., normal) or unbalanced (i.e., deviant). The influence of the hormones was not only on shape "but also on humor, character as well as the moral and intellectual personality of women" (Rocha Vaz 1940, pp. 37–38).

Biotypology was mobilized by physicians working on the construction of prescriptions for the educational field. With an eye toward its holistic view of the body, biotypology was used as a tool for understanding children's personalities and the changes in their bodies throughout the biological cycle. The biotypological evaluation of children, based mainly on anthropometrical measurements, was considered a guide to the education of the body; it helped to homogenize classes and became the basis for correcting the young. Individual constitutions were valued for the understanding of personality during childhood. Biotypology was a tool for correcting and setting children straight, as Peregrino Júnior (1940, p. 3) commented: "Everywhere, every time, biotypology's advice can be useful, cautious, apposite, clarifying. And how many mistakes it avoids! And how many disasters it prevents! How many evil it heals!" The practice of biotypology was one of the strategies for modernizing the country, constituting the Brazilian people, and establishing the future nation by determining how the new generations should be shaped.

Physical education and sports was another field in which biotypology was employed (Ramalho 1940);[12] this was considered vital in guiding the "rational realization of physical education". The knowledge obtained, together with quantitative and statistical practices from biometry, was seen as a way to normalize, manage, and determine the bodies or biotypes that were more fit for physical exercise and sport. Studies of biotypes find justification in labor by means of "organizing Human activity scientifically" and putting the labor force "where they belong" according to their individual physical characteristics (Rocha Vaz 1932, p. 150). These studies consider the existence of the skills and psychophysical qualities demanded by

[12] On biotypology in physical education and sports at the Army School of Physical Education, see Vimieiro-Gomes, Silva and Vaz in press.

different professions. This knowledge would help in "keeping workers away from jobs likely to provoke professional illness on the special morbid grounds of the individual thereby altering its productive capacity." Based on Nicola Pende, Berardinelli (1936) proposed that every type of professional was suitable for a biotype. The sthenic lankytype, for instance, given their strength, velocity, motor capacity, and time for decision-making, "fits the job of the woodworker, the plumber, the engraver, the driver". This was in contrast to the asthenic lankytypes, whose insufficient strength and low resistance to effort, emotion, and professional intoxication recommended them for jobs involving "more…the intelligence than the muscles" (Berardinelli 1936, p. 483).

21.4 Conclusion: The Forging of Biotypology in Brazil

> It would be better if Prof. Rocha Vaz, not knowing where he hangs about [a pun on Pende's name in Portuguese], puts his Viole in a bag [a pun on Viola's name and an idiomatic expression meaning something like shut up and go]. (Barros 1936, p. 23)

Biotypology textbooks circulating in Brazil in the 1930s and 1940s were the main vehicles employed by Brazilian physicians to validate biotypology in the scientific and medical agenda in Brazil.[13] A series of published textbooks were meant to forge biotypology as significant content for medical training on several fronts due to its supposed innovation in some epistemological aspects and the broad potential of its medical-political-social applications. Textbooks were not only the means for publicizing a set of accepted, desired, and unquestioned theories and practices that constitute the field (Vicedo 2012; Bertomeu-Sánchez 2006; Olesko 2006). They also proved to be the expression of the necessary discipline building and a transformative dimension in the attempt to consolidate biotypology according to the Brazilian medical-scientific culture as well as the medical, social, and political interests of the period.

By creatively receiving and locally adapting knowledge obtained from constitutional medicine, chiefly knowledge originating in Italy, Brazilian physicians gave biotypology its particular meaning and its uses in medicine and medical training. Some perspectives and practices of other sciences, such as anthropometry and statistics, were deliberately applied to clinical biotypology. Etiologic entities and local explanations for diseases were associated with the idea of an individual constitution and a holistic perspective of the body. Quantitative and qualitative classification patterns and normality parameters were (re)created according to the heterogeneous reality of the bodies of Brazilians. These procedures were connected with ongoing racialist debates, as seen in references to anthropological and racial categories. The merging of theoretical and medical concepts in

[13] There is no evidence of the creation of societies or journals concerning biotypology or constitutional medicine in Brazil.

biotypology is ambivalent, observing individuality and normalizing and grouping people according to types.

The quotation that opened this section sarcastically summarizes the physician Abelardo Barros's criticism toward Prof. Juvenil Rocha Vaz and the group of biotypologists regarding the limits of their efforts to legitimize biotypology as specific content and as a discipline that promotes scientific and medical grounds for the practice of medicine in Brazil. It calls attention to the changing features and the plurality of meanings, senses, and uses of biotypological conceptions based on Nicola Pende's and Giacinto Viola's 'Italian School' of constitutional medicine. It seems that attempts to develop the discipline of biotypology in Brazil did not occur coherently or passively and did not receive easy consent from the community of physicians.

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References

Albrizio, Angelo. 2007. Biometry and anthropometry: From Galton to constitutional medicine. *Journal of Anthropological Sciences* 85:101–123.
Barbara, M. Y., and G. Vidoni. 1933. *L´Instituto Biotipológico Ortogenético di Genova*. Genova: Carlo Badiali e C.
Barros, Abelardo Alves. 1936. *Estudo crítico do opúsculo do Prof. Rocha Vaz sobre o ensino médico*. Rio de Janeiro: Papelaria São José.
Berardinelli, Waldemar. 1933. *Noções de Biotypologia. Constituição, temperamento, caracter*. Rio de Janeiro: Francisco Alves.
Berardinelli, Waldemar. 1936. *Biotypologia: constituição, temperamento, caracter*. 3rd ed. Rio de Janeiro: Francisco Alves.
Berardinelli, Waldemar. 1942. *Tratado de biotipologia e patologia constitucional*. Rio de Janeiro: Francisco Alves.
Berardinelli, Waldemar, and João L. Mendonça. 1933. *Biotipologia criminal*. Rio de Janeiro: Guanabara Waissman Koogan.
Bertomeu-Sánchez, José Ramón, Antonio Gárcia-Belmar, Anders Lundgren and Manolis Patiniotis. 2006. Introduction: Scientific and technological textbooks in the European periphery. *Science and Education* 15:657–665.
Brown, Isaac. 1934. *O Normotypo Brasileiro*. Rio de Janeiro: Editora Guanabara.
Canguilhem, Georges. 1989. *The Normal and the Pathological*. New York: Zone Books.
Carneiro, Ana, Maria Paula, Diogo, and Ana Simões. 2006. Communicating the new chemistry in 18th-century Portugal: Seabra's Elementos de Chimica. *Science and Education* 15:671–692.
Cunha, Olívia Maria Gomes. 2002. *Intenção e gesto: pessoa, cor e a produção cotidiana da (in) diferença no Rio de Janeiro, 1927–1942*. Rio de Janeiro: Arquivo Nacional.
Ferla, Luis. 2009. *Feios, sujos e malvados sob medida: A utopia médica do biodeterminismo*. São Paulo: Alameda.
Ferraz, Alvaro and Andrade Lima Jr. 1939. *A Morfologia do homem do Nordeste. Estudo Biotipológico*. Rio de Janeiro: José Olympio.
Fleck, Ludwik. 1981. *Genesis and development of a scientific fact*. Chicago: University of Chicago Press.

Gavroglu, Kostas, Manolis Patiniotis, Faidra Papanelopoulou, Ana Simões, Ana Carneiro, Maria Paula Diogo, José Ramon Bertomeu-Sánchez, Antonio Gárcia Belmar, and Augustí Nieto-Galan. 2008. Science and technology in the European periphery: Some historiographical reflections. *History of Science* XLVI:153–175.

Gould, Steven J. 1996. *The mismeasure of man*. New York: Norton.

Hacking, Ian. 1990. *The taming of chance*. Cambridge: Cambridge University Press.

Hacking, Ian. 2007. Kinds of people: Moving targets. *Proceedings of the British Academy* 151:285–318.

Herschman, M. M., and C. A. M. Pereira. 1994. *A invenção do Brasil moderno: medicina, educação e engenharia nos anos 20 e 30*. Rio de Janeiro: Rocco.

Kemp, A., and F. C. Edler. 2004. Medical reform in Brazil and the US: A comparison of two rhetorics. *História, Ciências, Saúde—Manguinhos* 11:1–16.

Lawrence, C., and G. Weisz. 1998. *Greater than parts. Holism in biomedicine*. New York: Oxford University Press.

Leite, D. M. 1976. *O caráter nacional brasileiro*. São Paulo: Pioneira Editora.

Lipphardt, V. 2009. Der Körper als Substrat des Unterscheidens: vom Rassekonzept zur Humandiversität. In *Körper Wissen. Erkenntnis zwischen Eros und Ekel,* eds. Ernst Seidl and Philipp Aumann, 104–111. Tübingen: Museum der Universität Tübingen.

Marinho, Maria Gabriela S. M. C. 2001. *Norte-Americanos no Brasil: uma história da Fundação Rockefeller na Universidade de São Paulo (1934–1952)*. São Paulo: Autores Associados.

Olesko, Kathryn. 2006. Science pedagogy as a category of historical analysis: Past, present and future. *Science and Education* 15:863–880.

Ortiz, Renato. 1985. *Cultura brasileira e identidade nacional*. São Paulo: Editora Brasiliense.

Pende, Nicola. 1925. *La Biotypologie humaine, science de l'individualité*. Paris: M. Maloine.

Peregrino Jr., João. 1940. *Biotipologia pedagógica*. Rio de Janeiro: Imprenta/Liv. Odeon Editora.

Ramalho, Augusto Sette. 1940. *Lições de Biometria Aplicada*. 1 Vol. Rio de Janeiro: Papelaria Velho.

Rocha Vaz, Juvenil. 1929. *Clínica propedêutica*. Rio de Janeiro: Typ. Bernard Frères.

Rocha Vaz, Juvenil. 1932. *Novos Rumos da Medicina*. Rio de Janeiro: Guanabara.

Rocha Vaz, Juvenil. 1940. *A mulher e as glândulas de secreção interna*. Rio de Janeiro: Revista Médica Brasileira.

Ramos, Jair Souza. 2008. Como classificar indesejáveis? Tensões e convergências entre raça, etnia e nacionalidade na política de imigração das décadas de 1920 e 1930. In *Antropologia brasiliana: ciência e educação na obra de Edgard Roquette-Pinto,* eds. Nísia Trindade Lima and Dominichi Miranda Sá. Belo Horizonte: UFMG.

Schwarcz, Lilia Moritz. 1993. *O Espetáculo das Raças: Cientistas, Instituições e Questão Racial no Brasil 1870–1930*. São Paulo: Companhia das Letras.

Schwartzman, Simon. 2001. *Um espaço para a ciência: A formação da comunidade cientifica no Brasil*. Brasília: MCT/CEE.

Skidmore, T. E. 1998. *Uma história do Brasil*. Rio de Janeiro: Ed. Paz e Terra.

Souza, V. S. 2008. As leis da eugenia na antropologia de Edgar Roquette-Pinto. In *Antropologia brasiliana: ciência e educação na obra de Edgard Roquette-Pinto,* eds. Nísia Trindade Lima and Dominichi Miranda Sá. Belo Horizonte: UFMG.

Stepan, Nancy L. 1991. *The hour of eugenics: Race, gender and nation in Latin America*. New York: Cornell University Press.

Stoffel, Floriano. 1937. Biotipologia. *Revista de Educação Física do Exército Rio de Janeiro* 37:17–24.

Tracy, Sarah W. 1992. George Draper and American constitutional medicine, 1916–1946: Reinventing the sick man. *Bulletin of the History of Medicine* 66:53–89.

Vácha, Jirí. 1985. German constitutional doctrine in the 1920s and 1930s and pitfalls of the contemporary conception of normality in biology and medicine. *The Journal of Medicine and Philosophy* 10:339–367.

Vicedo, Marga. 2012. The secret lives of textbooks. *Isis* 103:83–87.

Vimieiro-Gomes, Ana Carolina, André Luiz Santos Silva, and Alexandre Vaz. in press. O “Gabinete Biométrico da Escola de Educação Física do Exército: medir e classificar para produzir corpos ideais, 1930–1940”. *História Ciências e Saúde–Manguinhos*, Rio de Janeiro.
Viola, Giacinto. 1926. *La medicina organismo scientifico unitivo*. Bologna: Cappelli.
Weffort, F.C. 2006. *Formação do Pensamento Político Brasileiro: Idéias e Personagens*. São Paulo: Ática.

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Epilogue

Ana Simões, Maria Paula Diogo, Kostas Gavroglu

By looking at the role played by the sciences in the universities of Europe since about the nineteenth century, the articles in this volume attempt to provide a historical background, which may be taken into consideration in the ongoing debates concerning the role of European universities in today's globalized world. *The idea of university as well as its particular forms in the various European regions* have been almost exclusively identified as something European. Although in very different contexts, universities remained a space for training intellectual elites and reinforcing existing social relations until WWII: Even if serving different "masters," from the dominantly religious institutions of the late Middle Ages until the Humboldtian universities of the nineteenth and twentieth centuries, these institutions produced new knowledge, codified it, provided the space for discussion and criticism and trained "experts," from whom decision-making elites emerged. The post-WWII massification of education without undermining the role of universities, seriously questioned the historically formed close relations of university graduates with elites. And the recent emphasis on universities as entrepreneurial institutions for which knowledge is a commodity to be traded in the globalized market of higher education has changed the traditional academic landscape, launching a debate that calls for an extended reflection on the role of universities in education and in society at large.

At the crux of these debates is the role of public university in a framework of commercialization of ideas and values. The autonomy and self-governance of the universities, the obligations of the state for the education of the citizens after high school, the relevance of disciplines which cannot bring funds to the university, and the status of senior staff as managers of programs, will be radically re-configured in the coming years. Recent trends towards planning a new kind of teaching through online classes—mainly the MOOCs (Massive Online Open Courses)—are even more challenging: They call for some serious reflection on teaching and learning processes, a reconsideration of the very meaning and function of higher-education, and of new forms of hierarchy within the academic world.

The organization of this book in four parts—Universities in the *longue durée*; Universities in diverse political contexts; Universities and academic research, and

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Universities and discipline formation—stems from the belief that the discussion of the role of sciences in the last 150 years of the history of European universities is enriched if informed by a historical approach that helps to put into perspective present debates about the new roles of academia and the sciences of a heterogeneous and diverse Europe. Therefore, the book builds on case studies covering different European geographic regions, which considered together can be taken as representative of the European space.

The first two parts of the book focus precisely on the relation between universities and their environments, using a *longue durée* point of view, and targeting a large range of topics such as sources of funding, governance debates, profile of students and gender considerations, impact on various university systems of different political regimes, the two World Wars, and the Cold War and its aftermath. The last two parts take a close-up view at two of the central tenets—research ethos and discipline formation—which have helped to mold the changing identity of European universities. Different universities in their relation with research and teaching, discipline choices in training students and affirming university prestige and status, the rise of laboratories within university walls, the role of experimental and field practices, journals and even university societies and clubs were the main actors of these dynamics.

One of the most intriguing questions raised in this volume is how European geopolitics has impacted on its universities as well as how the plural spatial dimensions of its universities—regional, national and European—have helped to shape an "European" institution. Certainly, any discussion based on a selection of major universities does not capture the diversity of academic landscapes which shaped the European continent, and which especially since the nineteenth century turned them into models to be appropriated in other continents (Ana Carolina Vimieiro Gomes). But even looking inwards it becomes clear that it was through the interplay of local factors and international stimuli that universities in various countries shaped their own identities (Helge Kragh), that various competing models were at stake, that the establishment of connections among an expanding grid of universities turned at times major universities into sites where often tradition inhibited transformations both in teaching and research (William Lubenow, Jaume Navarro), and that the so-called German model of a research university as a privileged site for laboratory science to thrive did not emerge ready-made, but was intensely negotiated by means of communication and networking involving academics from peripheral universities, rarely taken into consideration (Geert Vanpaemel).

What came to be known as the German university model resulted from diverging and often contrasting interpretations through a process which exemplifies the complex and ambivalent relation between center(s) and periphery(ies) (Geert Vanpaemel). In fact, the convoluted process of appropriation of a scientific research ethos in universities of peripheral countries was exemplified with three case studies related with the Faculty of Sciences of the University of Lisbon: The aspirations of the Polytechnic School of Lisbon to become a Faculty of Sciences were embodied in the creation of an observatory for astrophysical research, which nonetheless never worked as such (Luís Miguel Carolino); the creation of an academic journal was a move towards the affirmation of a distinctive identity for the Faculty of Sciences, and an effective means for the consolidation of a new research practice (Maria Paula Diogo, Ana Carneiro, Ana Simões); and later on, the drive to implement geological fieldwork research was a manifestation of different power relations involving institutions external to academia (Teresa Salomé Mota). Universities in other countries reveal how various solutions were under negotiation. The approach to research at the Physics Laboratory of Heike Kamerlingh Onnes of Leiden University introduced Big Science *avant la lettre* (Dirk van Delf); and the idiosyncratic solution to create an institution—the Centre National de la Recherche Scientifique (CNRS)—as the privileged space for research resulted from a reflection on the role of scientists and universities in French society: The perception of universities as privileged locus for the development of political consciousness, citizenship, national power, and as potential hotbeds for revolt were behind the decision to nurture scientific research outside universities (Robert Belot).

It is against this multifarious historical background that one should assess recent reforms and their imposition of specific directions for research development and the emergence of new disciplines. In fact, a short-term view of research oriented towards economic and market interests, responding to immediate needs and financial pressure has become dominant, and has modeled the connections between research practiced within university walls and the outside world, influencing concomitantly specific options for discipline formation.

Another tantalizing question raised in this volume is how changing political contexts (the Great War, WWII, and the Cold War) have acted as modifiers of the national dimension of universities, in such ways that besides the national variations propelled by geography, the same geographical location under different political frameworks may become a particularly revealing instance to assess the impact of national variations in building the character of the very same university. Examples discussed in this book include the university of Strasbourg in between the two world wars (Pierre Laszlo), and universities in Central Europe, with a special emphasis on the Czech University in Prague (Petr Svobodný) and the Technical University of Budapest (Gabor Palló). It is argued that the concomitant adaptations to different political regimes and *nationalities* have induced changes in university's perception of scale, perspective and focus of an unprecedented range and impact (Petr Svobodný).

Additionally, against the received view of universities as privileged autonomous spaces isolated from their outer contexts it has been discussed how universities became strongholds reflecting and propagating drastic political changes (Gabor Pallo). The amazingly close relations between academic spaces and politics have been exemplified in other instances as well. The concern for political stability was behind the implementation of various disciplines during the reforms of the Austrian universities in the mid-nineteenth century, aimed at the re-education of the Austrian youth, at stabilizing the Habsburg multinational empire, and at the modernization of the country (Christof Aichner). In Spain, in the period right before the civil war, the awareness of the need for self-government in teaching and research led to the implementation of technical education at the Autonomous Industrial University of

Barcelona (Antoni Roca-Rosell). Later on, during Franco's dictatorial regime, reforms were presented in public addresses as "technocratic," "apolitical" plans to modernize the Spanish university, inducing a strong opposition among students and the intellectual elite, who denounced the authoritarian, non-"liberal" status of the University (Agustí Nieto-Galan). On the other extreme side of Europe, the transition from the former model of USSR universities has been discussed in order to assess how political changes impacted on the dilemmas faced by Russian universities in the present context of globalization (Evgeny Vodichev). Of course, to understand how globalization has subverted former trends at the core of knowledge economy remains to be seen. Here again, reviewing governance debates as it has been suggested in relation to the University of Oxford (Andrew Boggs) might provide efficient tools to grasp the full extent of higher education reforms.

In the end, universities "cater" for students, the reforms have direct effects on them, and their active role has been a structural component in the life of European universities. From the late years of the eighteenth century when the financial status of students acted as a crucial determinant of education quality (Robert Wells) to the mid twentieth century when gender asymmetries have been hard to overcome, especially in what relates to scientific courses (Paola Govoni), the student body continues to be a crucial issue in the debates about university.

It is not unjustified to feel that the Humboldtian model is closing its historical cycle. The University as an entrepreneurial enterprise, in which even coursework is becoming "transactional rather than educational," according to the sharp wording of Rebecca Schuman, is fast becoming the new paradigm. Existing disciplines, newly emerging subjects, the research ethos, teaching, all will be radically re-conceptualized and such re-conceptualizations will have all kinds of practical repercussions. What was cherished as a public good, will surely give its place to an institution more attuned to the contingencies of the market place. Trying to instill students with what we have come to call as the values of the Enlightenment will not be a top priority. The problem today—as it has always been in the long history of the universities in Europe—is the re-invention of their relation to society, and the strengthening of the pluralism, which has historically characterized European academic landscapes.

Never a unified political and culturally uniform whole, the asymmetries and tensions between regions and states have been constitutive of the very idea of Europe, and of its distinctive institutions. Today as in the past, the biggest challenge faced by Europe is, therefore, to learn how to creatively accommodate and further cultivate diversity. Today as in the past, the challenges faced by European universities should build on their capital of civilizational memory, on the lessons of a *longue durée* view as they relate to the construction of their evolving identity. Transformations oblivious of the rich past of European universities are certainly doomed to failure. By bringing to the forefront past decisions, strategies and options, this volume contributes to enlighten on-going debates.

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