ECO-MANAGEMENT ACCOUNTING

ECO-EFFICIENCY IN INDUSTRY AND SCIENCE

VOLUME 3

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Eco-Management Accounting

Based upon the ECOMAC research project sponsored by the EU's Environment and Climate Programme (DG XII, Human Dimension of Environmental Change)

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Foreword

The ECOMAC project (Eco-management Accounting as a Tool of Environmental Management) has provided a framework for linking environmental management with management accounting. It was funded in Theme 4, 'Human Dimensions of Environmental Change' in the EU Environment and Climate Research Programme.

The project is of high policy relevance by contributing to the on-going debate on eco-management accounting, reporting and indicators. It is also an area needing further research.

I would like to thank the research team, companies that participated as associated contractors, and the advisory panel.

Jonathan Parker
DG XII/D-5, European Commission
Theme on Human Dimensions of Environmental Change

Preface

The ECOMAC project

This document is the final report on the project 'Eco-management accounting as a tool of environmental management' (ECOMAC). This research project was conducted under the Environment and Climate Programme (Human Dimension of Environmental Change) of the European Commission (DG XII).

The ECOMAC project investigated how companies are using or intend to use environmental costs and benefits figures in support of their decisions, and what they have been doing to remedy the limitations of conventional management accounting in this area. The research was largely explorative in nature, but the project also produced a structured overview of the subject and made suggestions and recommendations as to how companies could improve their own environmental accounting.

The contents of this report

The fieldwork was mostly done in 1996 and 1997. This report deals with the results of this fieldwork, and comprises a survey of 84 European companies – both small and medium-sized enterprises (SMEs) and large corporations – and 15 company case studies (most of them large international enterprises), which provided illuminating empirical materials, in terms of problems and solutions.

Before going on to chapters specifically devoted to the survey and the case studies, the report presents the Ecomac Framework, which relates results from the literature to the project's fieldwork, producing a consistent and illuminating overall picture of eco-management accounting in relation to management in general and environmental management in particular.

The partners

The successful execution of the ECOMAC project has been accomplished by a considerable number of people and companies. The Project Management Board – the project's board of contractors and steering committee – consisted of one representative of each of the following partners:

1. Fondazione ENI Enrico Mattei (Italy);
2. IBM Deutschland (Germany);
3. Erasmus Centre for Environmental Studies (the Netherlands);
4. United Kingdom Centre for Economic and Environmental Development (UK Ceed) (the United Kingdom); and
5. TNO Centre for Technology and Policy Studies (the Netherlands).

The Project Management Board's membership was as follows:

Matteo Bartolomeo represented the Fondazione ENI Enrico Mattei (Milan, Italy), which has pioneered the development of environmental management accounting in the Italian oil industry, in particular by introducing an eco-balance sheet. Matteo conducted the project's fieldwork in Italy and co-authored the chapter on the Ecomac Framework.

Dr Jan Jaap Bouma represented the Erasmus Centre for Environmental Studies of Erasmus University (Rotterdam, the Netherlands), which has played a major role in putting eco-management accounting on the Dutch research agenda. Jan Jaap conducted the project's fieldwork in Germany and co-authored a publication on the survey and this final report's chapters on the analysis of the survey and the case studies.

Peter Heydkamp represented IBM (partly together with Rob Nijman). As environmental programs manager, Peter made an important contribution to the project by sharing his practical insights with the project team and by hammering home the business logic behind much of a company's environmental and accounting policies. Peter assisted in the fieldwork in Germany, particularly in regard to IBM Deutschland's participation in the survey and the case studies.

Professor Peter James represented UK CEED. As director of the Centre for Sustainable Business and Visiting Professor of Environmental Accounting at the University of Wolverhampton, Peter developed important research activities in the field of eco-management accounting in the UK, together with Martin Bennett (an accountant and senior researcher in charge of the environmental accounting research programme of the University of Wolverhampton), who also became involved in the ECOMAC project. Peter and Martin conducted the fieldwork in the UK and made a pivotal contribution to the development of the Ecomac Framework. Peter also directed the development of the project's educational materials.

Dr Teun Wolters represented TNO Centre for Technology and Policy Studies. Together with Jan Jaap Bouma, he launched the idea of developing the project. In the Netherlands, he discovered the relevance of eco-management accounting when conducting a project on environmental investments as business opportunities. Teun was the project's co-ordinator and organised the fieldwork in the Netherlands (which included elaborate case studies in four Dutch companies who participated in the project as associate partners). He co-authored a publication on the survey and this final report's chapters on the survey and the analysis of the case studies. Partly as a means to disseminate the project's results, Teun initiated the Eco-Management Accounting Network (EMAN). This network held its first conference in December 1997, hosted by the Fondazione ENI Enrico Mattei in Milan (Italy). The second EMAN conference took place in Rome, November 1998 as a meeting connected with the Greening of Industry Network.

Other persons who contributed to the project

Of course, along with the researchers mentioned above, a substantial number of other persons contributed to the project, so that it is almost impossible to mention them all. However, some of them cannot be omitted here. First, I refer to the researchers involved in the Dutch case studies. On top of a review of certain accounting practices, which as was done in all case studies, the Dutch case studies consisted of time-consuming investigations of particular processes and an exploration of the implementability of certain new accounting tools, which required several months of intracompany research work. For each of these case studies, the following post-graduate students of Tilburg University were engaged: Maurice van der Mark, Peter Saris, Marijn Baarda and Stefan Verdonschot.

Together with their university and company-based supervisors, the Dutch case studies were designed and coached by Professor Foppe de Walle (the bedroom furniture company and the chemical company) and Teun Wolters (Xerox at Venray and Meerssen Papier). Willem Huntink of TNO assisted in the performance of the Xerox Venray case study. John Janssen of Xerox Venray took care of an update of the study in the light of changes which took place after the study.

Foppe de Walle has also contributed to the development of the research proposal. Michiel Wind co-edited Chapter 4 (summaries of the case studies) and co-authored the case study on Meerssen Papier.

In the Netherlands, Bianca Harderman and Annette van der Hoek assisted in the execution of the survey. In Italy Stefania Borghini and Giorgio Vicini played a major part in the research activities, while Tatjana Becksmann did the same in Germany. Professor Wim Hafkamp of Erasmus University attended several workshops and contributed to the discussions on the project's methodology.

The participation of companies

The project could not have been carried out without the participation of a number of companies, which played roles in the survey, the case studies and the testing of the Ecomac Framework. I am very grateful for their involvement. A special part was played by the Dutch companies who participated in the project as associated partners. Their willingness to participate affirmed that corporate environmental accounting is a topic that deserves the attention of professionals working within companies. On the whole, the 15 companies supplied a great deal of new information, which made it possible to give eco-management accounting a better and more diversified empirical basis.

Advisers

The project benefited from the advice on the quality of the work and its dissemination offered by the four members of the project's Policy and Scientific Review Panel: Roger Adams (ACCA, UK), Josef Haag (business consultant, Germany), Pedro Henriquès (EU, DG

III), and Peter Lancake (Shell International). Moreover, the project was given useful advice by Bill Watts and Jonathan Parker, who were the EU's scientific officers for the project.

The team at work

The different phases in the project's execution were marked by special central workshops during which the respective steps in the project were discussed and decided upon by the Project Management Board. The project is thus really the result of the joint efforts of the partners. The timing of the work was repeatedly a cause for concern. The background of the researchers and their attachment to the subject of eco-management accounting, formed a solid basis for the project's successful completion. As the project's co-ordinator I am very grateful for the team's commitment throughout the duration of the project.

While the project was running, EIM Small Business Research and Consultancy became my new employer. I very much appreciate both TNO-STB and EIM for enabling me to continue and complete my work for the ECOMAC project. EIM's secretarial office did a great job in processing all the documents which finally resulted in the present book.

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Zoetermeer, February 1999

1 The Ecomac Framework

Matteo Bartolomeo
Martin Bennett
Peter James

1.1 Introduction

The Ecomac project reflects a growing interest in the relationship between environmental management and management accounting. This interest is being driven in large part by:

- the desire of managers and others to gain a better understanding of the financial costs and benefits of environmental actions
- the belief of academic researchers and policy-makers that the topic is central to the further development of environmental management
- the trend in environmental policy towards incentive-based forms of regulation which require organisations to develop a greater sensitivity towards environment-related cost and benefit signals
- the demands of both external stakeholders and internal managers for reliable data, so that an organisation's environmental performance can be evaluated.

The aim of this project was to build on the existing literature and practice (see chapter 2) and to analyse the current status of environmental management accounting in Europe. Its specific objectives were to:

- explore the possible contribution of management accounting to environmental management within the European context
- develop a conceptual framework to map and analyse the relationship between the two activities
- disseminate the results to business, policy-makers and others.

These objectives have been met by:

- a literature survey
- a questionnaire survey of 84 companies in Germany, Italy, the Netherlands, the UK and Ireland
- detailed case studies of 3-4 companies in each of the four countries
- preparation of educational materials.

This document is meant to provide an overview of the project results and to outline an 'eco-management accounting' (Ecomac) framework as a conceptual model of the field. It is primarily targeted at academics, policy makers and business staff with a deep interest in the topic. An accompanying manual has been produced for practitioners to put the results and examples of the project into a more generally accessible form.[1]

[1] M. Bennett and P. James, *Applying Eco-Management Accounting,* Wolverhampton University, UK, 1999 (see Ecomac webpages for details).

The report is structured as follows:

- section 1.2 outlines the current status of corporate environmental management and highlights information gaps which can potentially be filled by management accounting practitioners and systems
- section 1.3 analyses the current theory and practice of environmental management accounting and how far this meets the needs discussed in the preceding chapter
- sections 1.4 and 1.5 summarise the results of the project's empirical research into these issues as they apply to European companies (full details are contained in chapters 2 and 4)
- section 1.6 considers their implications for the project's four main hypotheses
- section 1.7 develops an eco-management framework which distinguishes three crucial domains - management and financial accounting, environmental and energy management, and other areas of management - and the contextual factors of structure, culture and processes which influence and link them
- sections 1.8, 1.9 and 1.10 discuss the objectives, data inventory, and analysis and decision-making techniques which are characteristic of each of the three domains: management and financial accounting, environmental management, and other areas of management
- section 1.11 discusses the nature of structure, culture and processes in organisations, and their importance to eco-management accounting
- section 1.12 considers the relationship between eco-management accounting and sustainable business
- section 1.13 provides conclusions, and considers their implications for policy-makers, business, and the functions of accounting and environmental management.

1.2 Environmental management

Business now has several decades' experience of environmental management - and of the changing regulatory and social demands for environmental action by business. This is reflected in a growing sophistication and the development of new activities and approaches. These include:

- attempts to calculate the financial costs and benefits of environmental actions
- attempts to integrate environmental considerations into mainstream business decision-making
- a growing emphasis on the detailed measurement of environmental performance, for both reporting to external audiences and for use in internal decision-making
- the development of concepts such as life cycle management and cleaner production, which require organisations to consider and take responsibility for the upstream and downstream effects of their operations
- incorporation of the concept of sustainable development into environmental management and other areas of business, such as international trade relations.

One common feature of these areas is that they potentially require interaction between the environmental management function and the accounting function of a business. The following sections discuss this in greater detail.

1.2.1 Financial costs and benefits of environmental action

There has been a growing realisation in business that environment can affect the profits and financial position of a business (Cairncross, 1995; DeSimone and Popoff, 1997; Schmidheiny and Zorraquin, 1996). Some manifestations of this include:

- Substantial levels of liability for cleaning-up historic damage or for cleaning-up and compensating after environmental incidents
- High levels of capital and operating expenses for pollution-control equipment as a result of tightening legislation
- Additional costs incurred as a result of public concern over environmental issues, e.g. Shell's disposal of the Brent Spar oil-storage platform at a much higher cost than had been originally anticipated
- The introduction of eco-taxes and other incentive-based forms of regulation in a number of countries.

The extent of environment costs - and the opportunities for controlling and minimising them through appropriate management action - has been demonstrated by a number of initiatives. 3M calculates the accumulated first years' savings from all initiatives carried out under its pollution-prevention pays (3P) programme, and states that it has saved over $600 million since the programme's inception in 1975. Baxter goes even further and produces an annual corporate environmental financial statement with details of expenses and savings (one of the Ecomac case studies has also helped to extend this approach to a Baxter site - see below). Studies of 6 USA sites by the World Resources Institute also found that, on their definition of environmental costs, they comprised almost 22% of non-feedstock operating costs at Amoco's Yorktown refinery and 19% of the manufacturing costs of a DuPont agricultural pesticide (Ditz *et al.*, 1995).

In the UK, in the first phase of the Aire and Calder Valley study (Johnston, 1994) potential improvements worth £2 million p.a. were identified across the 11 industrial sites studied, with more longer-term possibilities in prospect as the project progressed. 72% of the proposals which were stimulated by the project had pay-back periods of less than 12 months - in many cases of zero, where they were simply 'good house-keeping' measures which required no initial outlay.

Similar findings have been reported by other European projects, particularly in the Netherlands (Dieleman *et al.*, 1991; Wolters and Bouman, 1995).

Of course, these findings are not universally applicable and there will be cases when environmental actions have a net cost (Walley and Whitehead, 1994). Nonetheless, these stimuli have created interest in the topic amongst a variety of participants. For example:

- senior managers have sought a better understanding of financial costs and benefits in order to reduce costs, minimise risks and prioritise between different environmental management options
- environmental managers and others have sought to reinforce an environmental case for a proposed course of action with a business case which is persuasive to senior managers
- external financial and other stakeholders have sought reassurance that companies are minimising their environmental costs and risks.

This interest has been strengthened by the intense cost pressures on European business during the 1990s. As a result, there has been increasing pressure to contain environmental expenditures and to demonstrate that environment can make a contribution to mainstream business.

1.2.2 Integrating environment into mainstream business

The environmental impacts of an organisation are typically dispersed across its operations - production, heating, cooling and lighting of buildings, transport, and other activities, all have some form of environmental effect. Ameliorating these effects therefore depends upon actions by a wide variety of people. Environmental managers frequently have little direct authority in these situations and must therefore achieve their aims by influencing the thinking and activities of their colleagues in other functions, particularly those with line management responsibilities in operational areas. The need for this has been reinforced in many companies by the trend towards decentralisation of power from central functions to autonomous business units.

Additionally, a large proportion of environmental improvement is achieved 'unintentionally', i.e. as a consequence of investments or activities which are implemented primarily for non-environmental reasons but which also deliver substantial environment benefits (James *et al.* 1997). This can often be increased further if environment is considered explicitly when changes are being made, e.g. when the accounting function and senior managers are assessing new investments.

Similar considerations apply to achieving quality in business and it is therefore unsurprising that many companies have applied the principles and practices of total quality management (TQM) to their environmental activities. For example:

- TQM's emphasis on the importance of *customers* and its broadening of the term beyond mere purchasers of a product provides a useful framework for considering and responding to the demands of environmental stakeholders.
- TQM's emphasis on commitment to *continuous improvement* is very helpful to organisations wishing to move beyond mere compliance with environmental regulation.
- TQM's focus on eliminating the *root causes* of problems rather than their symptoms fits with the growing awareness that pollution prevention is often an environmentally and

financially superior approach to environmental problems than 'bolting on' pollution-control equipment at the 'end-of-pipe'.

- TQM's belief that quality is *everyone's responsibility* within a company fits well with the growing awareness that all employees have to make a contribution to environmental performance.
- TQM's concern with calculating the *cost of (non) quality* to demonstrate that improvement is financially worthwhile can easily be translated into the cost of (non) environment (James, 1994).

By demonstrating that environmental action can be financially beneficial, cost of (non) environment calculations can also be important in ensuring the senior management support which is essential for successful integration.

At a lower level TQM has also placed considerable emphasis on the introduction of systematic and documented procedures. The environmental equivalent of this is an environmental management system (EMS). As section 1.9.3 discusses, accounting data - both financial and non-financial - is central to the development and operation of such systems.

1.2.3 Environmental performance measurement and reporting

There are growing external and business pressures on organisations to measure and report their environmental performance (Bennett and James, 1998a; Bouma *et al.*, 1995; Epstein, 1996). The external pressures include:

- demands for information by regulators and other government agencies
- public concern about risks to health and ecology from chemical and other emissions
- the desire of investors and lenders for reassurance that their financial interests are not jeopardised by poor performance
- pressures from industry associations and other business sources to improve performance.

Business drivers include:

- the need to demonstrate that environmental objectives and policies are being met
- the need for information in order to set future objectives and make specific environmental decisions
- demands for more environmental data from customers.

In particular, there is growing evidence - for example, the Zeneca and other case studies carried out for this project - that a detailed understanding of the flows of energy, materials, water and other resources into, through and out of sites is valuable in many ways. It is an essential basis for determining significant environmental effects and for determining environmental management policy, it highlights opportunities for cost reduction, and it can also be perceived by regulators and other stakeholders as an indicator of good management generally.

Gray *et al.* (1993) and others have pointed out that accountants and the accounting profession have much to contribute to this and to other environmental performance measurement and reporting activities. Specifically, their experience is, or could be, valuable with regard to:

- the generation, collection and analysis of resource and other data, much of which will be held within accounting records and systems
- verification of data collection and analysis methods
- reporting and communication of quantitative data.

1.2.4 Life cycle management

Many companies are paying closer attention to the topic of supply chain management. This is partly because outsourcing and other developments make them more dependent on suppliers. But it is also because collaboration between suppliers and customers, rather than acting independently, can sometimes lead to superior outcomes for both sides.

Environment is an important part of supply chain management. Environmental policies and regulations, and public attention, have historically concentrated on the materials processing and manufacturing stages of this chain. Their impacts are large and obvious and they are easy to control. However, a growing proportion of environmental impacts are caused by the creation of raw materials and the use and disposal of products. In the case of cars, for example, around 80% of total energy consumption from their manufacture to their disposal is accounted for by the fuel to drive them.

The attention of governments, NGOs and leading companies is therefore extending towards a life cycle management which seeks to understand and manage all the stages of a product's life from 'cradle' to 'grave'. Some examples include:

- The growing use of life cycle assessment (LCA) tools to identify and analyse all of a product's lifetime impacts.
- Government and NGO measures to influence raw material choices - for example, carbon taxes on fuels or certification of sustainably produced timber
- Requirements to provide information and/or meet specified targets for the environmental performance of products in use (e.g. fuel consumption or emissions from cars)
- Requirements for 'producer responsibility' for end-of-life goods such as cars or electronic equipment, often backed up by restrictions or levies on specific disposal routes.

The results of these actions can be a need for expensive modification of products and unexpected liabilities for disposal. For example, the nuclear and oil industries have discovered that it can also be much more costly to decommission equipment than was originally anticipated. Producers can potentially incur liabilities as a result of environmental problems related to their products.

Companies can also incur environment-related costs as a result of action or inaction by their suppliers and customers, both direct or indirect. An example of potential supplier-

related costs is the USA requirement that equipment be labelled as using CFCs if these have been utilised at any stage in their manufacture. In principle, this can result in a company incurring the costs and dis-benefits of such labelling - such as a lower price or even exclusion from some markets - simply because CFCs have been used by one of its suppliers. In the case of customers, costs can be incurred as a result of take-back legislation which requires them to work with manufacturers in organising end-of-life disposal of products or packaging.

The long-term solution to these problems is to prevent them by incorporating environment into the design of new products. The short-medium term solutions are to ensure that costs are minimised as much as possible. Financial data is important in both cases.

1.2.5 Sustainable development

Most national governments have endorsed the principles of sustainable development, as defined by the Agenda 21 document which resulted from the 1992 Rio Earth Summit. To a greater or lesser degree, they are now seeking to implement these. Bodies such as the World Business Council for Sustainable Development (WBCSD) and its member organisations have also devoted increasing attention to their implications for business and how to implement them in practice (DeSimone and Popoff, 1997).

Although it is difficult to develop any precise definition of sustainable business (see chapter 10) it is clear that its implications include:

- Radical improvements in environmental performance - a minimum 'factor four' reduction in environmental impact for the delivery of final goods and services to consumers according to some estimates (von Weizsäcker *et al.*, 1997)
- Increased 'eco-efficiency' through the development of new products and processes which can create more economic value per unit of environmental impact (DeSimone and Popoff, 1997; Fussler with James, 1996)
- A long-term perspective in decision-making, with greater emphasis on the impacts of decisions on future generations
- A greater degree of internalisation of the external environmental costs of business (Rubenstein, 1994).

This implies the need for environmental and management accounting systems to collect new types of data, such as that relating to environmental effects throughout the entire product chain. It also suggests that more attention needs to be paid by accountants and others to identifying and raising internal awareness of long-term cost trends.

1.2.6 Conclusions

It is clear that the more advanced that environmental management becomes, the more important it is to have good linkages between it and the accounting function. These linkages are necessary to:

- make use of data contained within accounting systems for the purposes of environmental management
- make use of data contained in environmental information systems for the purposes of management and financial accounting
- bring environmental considerations into critical financial management activities such as investment appraisal and product costing
- increase the environmental literacy of accountants and financial managers so that they can better understand the financial implications of environmental action or inaction and create or improve linkages with environmental staff
- increase the financial literacy of environmental staff so that they can build better relationships with accountants and mainstream managers and make better business cases for environmental action.

The next chapter considers these issues from the perspective of the accounting function.

1.3 Overview of accounting and the environment in business

There is now a considerable academic literature on the topic of accounting and the environment (for example, Bennett and James, 1998c; Gray *et al.* 1993; Gijtenbeek *et al.*, 1995; UNCTAD, 1996). This is supplemented by a number of applied research and demonstration initiatives, as well as by publications by professional and regulatory bodies on specific issues such as environmental liabilities. This chapter is based on this published literature, although some caution is needed as our research has found evidence of some discrepancies between the literature and the empirical practice which we encountered.

1.3.1 Four approaches

Like all accounting, that part which is concerned with environmental issues is a complex activity which can be defined in different ways. The different definitions relate to different emphases on what the content of the activity is - financial and/or non-financial data - and on its primary purpose, in particular whether its principal objective is perceived to be internal decision support or external reporting.

Content

The foundation of any accounting activity is 'score-keeping', i.e. the capture, collection, verification and processing of relevant data. In a broad view, environmental accounting is therefore synonymous with environmental performance measurement, i.e. concerned with a wide variety of financial and non-financial data. In particular, it would see the activities of what is sometimes called in Germany, 'eco-balancing', and in the Anglo-Saxon world, 'energy and materials accounting', as being an important part of its activity. Hence, environmental accounting is not necessarily confined to accountants - it can also be carried out by environmental managers and anyone else engaged in environmental score-keeping.

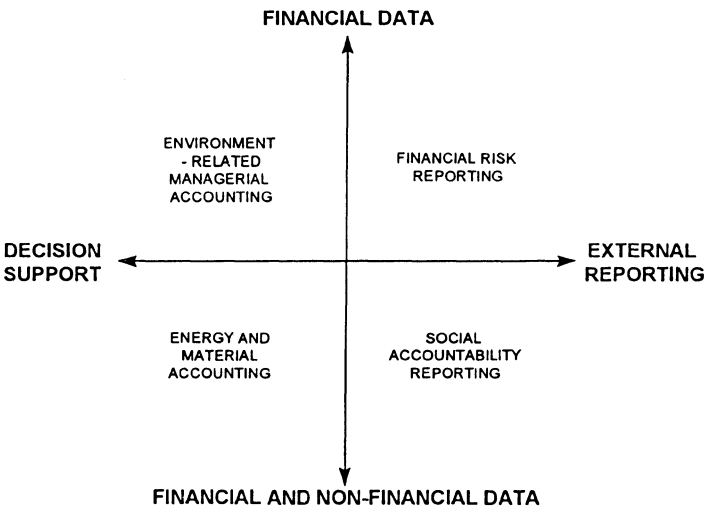
An alternative, narrower, approach is to define score-keeping solely in terms of financial data. This increases the relative importance of accounting professionals but still includes environmental managers and others who are generating financial data, e.g. figures on the costs of waste.

Purpose

One important distinction within accountancy is between management accounting, i.e. the provision of information for managerial decision-making and other managerial purposes, and financial accounting, i.e. reporting to external stakeholders about the company's financial probity. For example, information on liabilities arising from past environmental contamination is very important for financial stakeholders as it affects the value and risk of their investments. However, as a 'sunk cost' it is of much less relevance to internal decision-makers who must be more concerned that current actions do not create new liabilities or other future problems. Although the two activities are often inter-connected at business level - for example, being conducted by the same personnel and/or drawing on a single data system - the distinction is nonetheless important as it can influence the type of data collected and its reliability.

Figure 1.3.1 uses these variables to distinguish four broad approaches to environmental accounting at the business level - financial risk reporting, social accountability reporting, energy and materials accounting and environment-related management accounting.

Figure 1.3.1 Four approaches to business level environmental accounting



FOUR APPROACHES TO BUSINESS LEVEL ENVIRONMENTAL ACCOUNTING

Financial risk reporting

This activity is concerned with assessing the financial risks associated with environment - rather than environmental risks per se - in order to inform investors, bankers and others in the capital markets. These risks can be considerable, for example, with regard to liabilities associated with a need to clean-up contaminated land. It has been estimated that American industry may be under-provided for 'Superfund'-related clean-up liabilities by up to a trillion dollars (Schoemaker and Schoemaker, 1995). Liabilities are less in the UK and other European countries but can be significant for some individual companies. They may become more significant if legislation on this become more rigorous.

Social accountability reporting

In the UK, much of the interest shown by academic accountants such as Gray *et al* (1993) is an extension of the social accounting movement which flourished briefly in the 1970s. The initiatives made then failed to persist because, in the analysis of a leading proponent at the time:

- 'social accounting focused on external reporting that in many cases did not have internal corporate activities to back up those reports. It was neither institutionalised nor part of the central core of most organisations. It was driven primarily by public relations personnel and used only secondarily as a management tool.' (Epstein, 1996).

However, the social accounting approach has influenced debate and practice in the area of environmental reporting. In the UK, for example, its proponents have been central to the development of the ACCA's Environmental Reporting Awards Scheme (Gray *et al.*, 1996). Anecdotal evidence suggests that this is highly regarded in industry, and is instrumental in encouraging improvements and innovations in the stand-alone voluntary published corporate environmental reports which are the most visible indicator of corporate accountability to external stakeholders (Owen, 1992).

Energy and materials accounting

Many environmental impacts are related to flows of physical substances (fuels, materials, water , gases, etc.). Hence, this is the basic data used for life cycle assessment (LCA). Some experts therefore advocate that, if management accounting is to take environment seriously, the tracking and analysis of this non-financial information should become as important as the tracking and analysing of financial information (Birkin and Woodward, 1997a-f). This can also be seen as a logical response to the arguments for greater use of non-financial information made by Kaplan and Norton (1996).

One particular existing activity in this area which has been seen as relevant to management accounting is that of eco-balancing, which is particularly well developed in Germany (see Becksmann (1996) and section 3.9.3).

Environment-related management accounting

In recent years there has also been growing interest in developing a better understanding of environment-related financial costs and benefits as an input to conventional management accounting. Much of this work has been in the USA, for example:

- the Environmental Protection Agency's Environmental Accounting Project, which - in collaboration with organisations such as the Tellus Institute - has summarised definitions, developed a model for considering environment in investment decisions (known as 'Total Cost Assessment', or TCA) and developed research into trends and practices in industry both in general and in particular industry sectors such as chemicals and electroplating and in companies such as AT&T and Ontario Hydro (McLaughlin and Elwood, 1996)
- initiatives by individual companies, such as Baxter's development of an 'environmental financial statement' summarising the corporate costs and benefits of environmental action (and showing that the latter are at least three times greater than the former at both corporate and - as demonstrated by one of the project case studies - site level)
- academic and applied research, such as a survey of practice by Epstein (1996), a study by the USA Institute of Management Accountants (IMA, 1995), and the work of Bailey and Soyka (1996)
- a monograph by researchers at the World Resources Institute (Ditz *et al.*, 1995) reported detailed case studies of nine companies.

Tuppen (1996) has also anaiysed the USA situation from a European perspective.

Schaltegger *et al.* (1996) have provided a European overview of the field. Much of the practical work in Europe has been in the Netherlands, driven by that country's advanced environmental policies and move to incentive-based regulation (Bouma, 1998; Braakhuis *et al.*, 1995; Wolters and Bouman, 1995). There has also been work on developing typologies of costs and benefits as an outcome of a number of waste minimisation schemes in the UK (Business in the Environment and Environment Agency, 1996; Johnston, 1994).

Finally, the Spring 1997 issue of Greener Management International and a subsequent book (Bennett and James, 1998c) have collected articles from Europe and the USA.

1.3.2 Eco-management accounting

There is no objective way to choose a 'correct' definition of business-level environmental accounting from the four we have described and so choices have to be made for research purposes. Our own choice for the purposes of this project has been to adapt a fairly narrow definition, centred on the north-west quadrant of the diagram. Its twin parameters are a narrow definition of data - that expressed in monetary units, or of relevance to financial analysis - and the adoption of an internal management decision support perspective.

The main reasons for this choice are:

- a feeling that a management accounting perspective has been less developed in Europe than in the USA, combined with some evidence of a reappraisal of the value of the financial accounting approach (Bennett and James, 1997)
- the pragmatic argument that the best way to build credibility for the creation of linkages between management accounting and environmental management is to stay relatively close to generic management accounting activities and to produce data which has some immediate business value.

However, we believe that an essential characteristic of business-level environmental management accounting is that it supports environmental objectives as well as the objectives of generic management accounting. This will eventually require the integration of environmentally-focused financial and non-financial measurement. We therefore coin the term 'eco-management accounting' ('Ecomac') to describe it.

Research hypotheses

The research for the project was both inductive and deductive. The deductive component was summarised as four hypotheses for testing in the project's empirical research in Europe:

1. Logical relationships between management accounting and environmental management can be established via the existing production processes and products.
2. The linking of management accounting to environmental management will enhance the financial superiority of pollution-prevention measures relative to end-of-pipe measures.
3. Firm-based costs resulting from emissions to the environment are often not identified within conventional management practices. As a result, cost savings relating to environmental pressures frequently remain hidden.
4. Activity-based costing (ABC) is a promising approach to remedy the 'black box' nature of overheads. It can be applied so as to systematically quantify the cost-saving effects of environmental measures.

Section 1.6 assesses these in the light of the findings from a survey of accountants and environmental professionals in 84 European companies (summarised in section 1.4) and detailed case studies of aspects of environmental accounting in 15 European companies (see section 1.5).

1.4 The Ecomac Survey

A survey of 84 companies in four different countries formed a major part of the project. The sample was stratified by size, with 50% in each country being larger companies and 50% being small-medium sized enterprises. It was also focused on industries where environment is a significant strategic issue such as chemicals, pharmaceuticals, energy, and printing. In almost all cases, an environmental specialist and a financial specialist were

interviewed at each company. The findings are described in detail in chapter 2 and an accompanying publication (Bouma and Wolters, 1998).

Some of the questions replicated those which were carried out in a similar exercise in the USA by the Tellus Institute on behalf of the USA Environmental Protection Agency (White and Savage, 1995). However, the comparative results need to be interpreted with caution as the samples were different. The USA exercise was based on a larger number of firms and respondents, had less control over the identity of respondents, and had a greater proportion of responses from medium-sized and large companies.

The main themes which emerged from the survey responses can be summarised as:

- cross-functional goals and procedures
- some emphasis on pollution prevention
- moderate but growing general importance and strong specific interest
- diverse sources of information
- limited allocation of environmental costs
- equivalence of environmental investments
- short-term decision making perspectives
- problems of data reliability.

1.4.1 Cross-functional goals and procedures

A small majority of companies have formal environmental policy goals which are integrated into their business-economic policy goals (53%). A large majority of companies also had an environmental management system in operation (56%) or were in the process of introducing one (24%). Over half of all companies (58%) had formal procedures to ensure that environmental staff were involved in capital budgeting processes.

1.4.2 Some emphasis on pollution prevention

Most of the companies surveyed were seeking to prevent pollution by integrating environmental management into normal decision-making, thereby reducing any need for subsequent 'bolt-on' solutions. The business phases in which implementation of this was highest were production (74% of respondents) and R&D (61% of respondents). However, there is room for further improvement, for example, less than 50% of companies were adopting this in the product design, distribution, use/consumption or disposal stages of the life cycle.

1.4.3 Moderate but growing importance

On average, the companies surveyed were placing only moderate importance on environmental accounting - between 1.2 and 1.4 on a 1-3 index summarising different aspects of the topic. However, this disguises significant activity in a number of companies. Most

survey respondents also expected their environmental management activities to increase in future.

Moreover, there is considerable interest in some specific applications, particularly amongst environmental specialists. They were asked to assess the usefulness of seven areas or activities - the book-keeping system, budget-setting, budgetary control, capital budgeting, product costing, financial performance measurement, and non-financial performance measurement - both now and in the future. The highest ranked overall was capital budgeting, which 48% saw as having considerable or crucial importance to environmental management now and 61% expected to be of considerable or crucial importance in future. The two aspects of operational budgeting - budget-setting and budgetary control - were also highly ranked, with 33-34% seeing them as either considerably or crucially important now, and 53-56% believing that this would be the case in future. Interestingly - in view of the topic's previously prominence in the subject literature - the lowest ranked of the seven was product costing, with only 24% of environmental specialists believing this was of considerable or crucial importance to environmental management now, and only 39% for the future.

1.4.4 Diverse sources of information

This is one of the few areas of significant difference between the USA and Europe which emerged from our survey. In the USA, 51% of companies stated that their financial and management accounting systems were their main source of data on environmental costs. This compares with only 19% of European companies, a far larger proportion of whom stated that the main source was operational management systems. In particular, operational data such as process records emerged as being extremely important for most companies - often more so than data from accounting systems.

1.4.5 Limited allocation of environmental costs

Only 50% of the European companies were explicitly tracking environmental costs, compared to 83% in the US. The difference is especially marked at plant level, where only 18% of European companies were tracking environmental costs compared to 64% in the USA. However, the difference is less significant than it may appear as even the American companies were tracking only a small proportion of the costs which might potentially be classified under this heading. In both countries, most companies were tracking obvious environment-related costs such as energy and waste disposal (although not always identifying them as such) but paying little attention to others such as environmental fines or penalties, or insurance costs.

The residual differences between the USA and Europe are probably explained by the higher levels of liabilities and penalties in the former.

Within Europe, the survey also found that German companies were allocating costs to processes and products to a slightly greater degree than in the three other countries.

Given that many environmental costs are being allocated to overheads, the formulae which then assign these into individual cost objects is of some significance. On both sides of the Atlantic the main basis for allocation is labour hours (55% of USA companies and 33% of European), closely followed by production volume (53% in the USA and 24% in Europe). Several of the case studies - for example, those on Cartiera Favini and Philips - show how this can result in environmental costs being allocated to processes or products which do not in fact generate them.

1.4.6 Equivalence of environmental investments

The Ecomac survey showed that, whilst some urgent compliance projects might avoid conventional investment appraisal procedures, in general environmental investments are not treated differently to other proposed investments. In Europe 83% of companies have a common capital budgeting pool for both environmental and non-environmental investments - a very similar figure to the 86% of companies which do so in the USA. However, a quarter of all firms - and a much higher proportion in some sectors - used different assessment techniques for environmental projects.

1.4.7 Short-term decision making perspectives

Most decisions involve the commitment of resources. If this commitment is substantial, it will usually be subject to financial assessment. The time horizon used by such assessment techniques is therefore of great importance as the benefits of environmental investments are often long-term in nature but the costs are short-term. Most experts see the pay-back method of appraising capital investments as particularly inappropriate for dealing with such situations. This is because it does not consider the time dimension of cash flows and also because, in practice, it is frequently based on very short pay-back periods (under a year for several of the companies interviewed). Conversely, discounted cash flow forms of assessment do take account of longer-term returns, although their significance depends upon the discount rate used and the time horizon over which costs and benefits are recognised. The lower the discount rate and the longer the time horizon, the more that longer-term returns will be recognised.

In practice, most of the European firms surveyed used the pay-back method as one of their assessment techniques and 35% used it as their primary one, making it the most popular assessment technique. This contrasts with the US study, which found return on investment (ROI) to be the most common main investment technique. It does however correspond to other research on investment decisions generally within companies (Drury *et al.*, 1993). Although the European companies in our study which were using the pay-back method were, on average, using longer pay-back periods than were their counterparts in the USA, it is nonetheless disquieting that it has such importance. This is particu-

larly true of Italy and the UK, which place even greater emphasis on pay-back than do their Dutch and German equivalents.

1.4.8 Data reliability

Some of the project's survey interviews and case studies revealed considerable doubts about the reliability of much environmental and environment-related cost data within companies. One reason for this is that direct measurement of many environmental parameters is often impossible or unduly expensive, so that data has to be derived from other parameters, e.g. by measuring inputs and outputs to estimate losses or by applying a conversion factor to estimate the carbon dioxide emissions of fuels. The margins of error are often considerable and can sometimes outweigh any trend variations. Variations in definition can also create difficulties. The problems of ensuring reliability are particularly pressing in large organisations, which are often collecting data at different levels - for example, the corporate centre, the division and an individual business unit or site - as well as at multiple locations in different countries.

1.5 The Ecomac Cases

The fifteen cases researched for the project covered a variety of themes, including 'costs of non-environment', product costing, waste minimisation, environmental costs in product development, and end-of-life disposal costs. They also provided a mix of both 'problems' - i.e. cases where the research objective was to reveal problems and demonstrate possible solutions to them - and 'solutions', i.e. studies of companies which have taken action and been successful. The Dutch cases also received resources from the companies concerned and had more of an 'action research' orientation than the others. Detailed summaries of the cases are provided in chapter 4, and an analysis of their findings in chapter 30.

1.5.1 Germany

The IBM Deutschland case examines the accounting issues related to end-of-life disposal of computers. As IBM has traditionally leased many of its computers, it has for some years operated autonomous logistics centres to deal with and obtain maximum value from returned equipment. The company also has a sophisticated accounting system, based on activity-based costing, which has tracked many aspects of these end-of-life activities. Even so, proposed German legislation on product take-back created a need for new kinds of data on end-of-life costs. This was needed both to feed into product designers' decision-making and also to provide data on the amount which should be accrued in the manufacturing phase in order to meet end-of-life obligations - a figure of some importance to the company and also to tax authorities, since it will be eligible for tax relief. The case shows how much easier it is to generate such data when an ABC system is in operation, but also notes the dangers of relying on historic data - which may be rendered obsolete by changes in legislation and other factors - when undertaking life-cycle costing.

Another German case examined the Philips Deutschland glass factory at Aachen, which produces glass screens and cones for the cathode ray tubes used in televisions and other display equipment. The company was interested in this issue partly because of customer and other external pressures but also largely because of an official German requirement that the company provide environmental cost data. The research found not only a significant number of environmental costs which were being assigned to overheads, but also that environmental costs were often being combined with others under a single cost code. It also found an important mis-allocation of the costs of water treatment. These were being assigned to the two main processes on the basis of their share of output - i.e. two thirds to glass production and one third to glass finishing. However, wastewater from glass production did not require treatment, so the whole of this cost should have been assigned to finishing - that is, the existing allocation puts an important cost element in glass finishing at only one third of its real value. The study also found mis-allocation of costs to the plant's individual products, although these probably cancelled each other out.

The Sony Deutschland case notes the difference in the pattern of costs and in the areas of focus between distribution and service organisations and manufacturing companies. Sony Deutschland is in the former category and is therefore less concerned with issues of capital budgeting and more with questions such as the costs of environmental management staffing and of product-related topics such as end-of-life takeback and packaging disposal costs. On the latter, the research found that the absence of any effective interface between the information system recording data for, and payments to, the packaging disposal agency, Duales System Deutschland (DSD), made it impossible to allocate disposal costs to individual products. Even had this been possible, the case shows the need for an appropriate organisational context to ensure effective action - in this case key decisions about product packaging are taken outside Germany, so that even if cost data were available it would not necessarily lead to differences in practice.

1.5.2 Italy

The Italian cases reflect the widespread application of 'environmental balance sheets' in that country, with all four cases on companies which had introduced them. Despite this, the two studies - on Cartiera Favini and SGS-Thomson - which identified cost identification and allocation in some detail nonetheless found many examples of hidden or inappropriately allocated environmental costs.

This mis-match was particularly striking in the case of Cartiera Favini, a small 'green paper' manufacturer which is often seen as Italy's most ecologically progressive company. The company places great emphasis on the sustainability of its processes and products, which make use of unusual raw materials such as unwanted algae from the Venice lagoon! To this end, it regularly compiles an environmental balance sheet, and publishes an annual summary of the data, as well as conducting regular life-cycle assessments. Even so, the research study found that some significant environmental costs were being allo-

cated to products and processes on the basis of generic formulae which did not reflect the real cost drivers. One process in particular was based on a completely closed water cycle which therefore did not generate any wastewater, but was nonetheless being allocated a share of the costs of the company's wastewater treatment plant. The study found too that the company's main investment appraisal technique was pay-back - perhaps the least environmentally sympathetic of tools. It was also making no attempt to calculate the financial benefits of its actions, even though many of its products were gaining a pricing premium from their environmental attributes - for example, an additional 10% for total chlorine free pulp compared to that produced by methods using chlorine.

The case on the Agrate plant of the Italian microelectronics producer SGS-Thomson also demonstrates that hidden costs can be significant even in companies with a well developed quality culture. The company has good data on, and control of, energy and material flows, which are summarised in a quarterly 'site environmental balance', and routinely calculates the 'cost of non environment'. A recently introduced corporate level Environmental Data Bank also collates, for all the company's sites, data on energy, materials and water consumption, emissions and wastes, and other environmental impacts such as noise. Nonetheless, the research found several important costs which were either remaining in overheads or were being allocated on the basis of formulae which did not reflect the real relationships between the actual costs and the activities which were driving them. The most important area affected by these factors was the treatment of solid wastes and wastewater.

Hidden costs were less significant at the oil production company, AGIP. The company has a sophisticated accounting system which identifies and allocates most significant costs to well defined activities - principally production and drilling of individual wells. However, the research did find that although the company was being proactive in taking decommissioning costs into account when making investment decisions, this was treated as a fixed cost rather than something which could be influenced by design decisions. It also found that little attention was being paid to the possible generation of future liabilities.

This was not the case at Italiana Petroli, a retailer of petrol. Faced with potential issues of ground contamination and other impacts from leakages at its petrol stations, the company has developed a sophisticated model to assess the risk of this occurring and the likely severity of the consequences. It then calculated the costs and benefits of taking remedial measures, such as building double-skinned storage tanks, at the most risky sites. These proved to be uneconomic when a limited inventory of costs and benefits were taken into account but cost-effective when contingent costs such as future liabilities, damage to image and higher insurance premiums were taken into account. The company therefore initiated a proactive programme for its riskiest sites.

1.5.3 The Netherlands

Two of the Dutch cases, on a bedroom furniture company and a chemical company, focused on applying the cost of non-environment approach, known as the 'model of environmental costs' (MEC) (Diependaal and De Walle, 1994). The model distinguishes between five cost categories - prevention, process-integrated correction costs (created by changes in production processes to reduce emissions or waste production), effect-mitigating correction costs (of treating and monitoring wastes), internal failure (all costs incurred for environmental restoration, ultimate disposal of waste and clean-up of polluted sites **inside** the manufacturing plant boundaries) and external failure (similar costs incurred **outside** the manufacturing plant boundaries for which the company is liable). Relatively high prevention costs (categories 1 and 2) means that environmental problems are being anticipated and future correction and failure costs reduced. Conversely, high correction and failure costs (categories 3,4 and 5) indicate poor environmental management.

The producer of bedroom furniture, had around 400 employees. The research found that its environmental costs under the MEC model were almost four times those revealed by conventional accounting and equivalent to around 1.2% of turnover and 1.7% of production costs. As the MEC definition excludes contingent costs and the costs of processing materials which end up as waste, the real environmental costs are even higher. The study recommended that in future the company should establish environmental targets and help achieve these by introducing a carefully-defined environmental cost code into its accounting system.

In the case of the chemical company, the research examined two sites. It found that, under the MEC definition, environmental costs were around 2% of total operating costs at both sites. This was over 60% higher than the accounting systems' environmental costs code and around 30% higher than the figures being reported as environmental expenditure to the Netherlands Central Bureau of Statistics. The main explanation of this in both instances was the exclusion of environment-related labour costs. Again, as the MEC definition excludes contingent costs and the costs of processing materials which end up as waste, the real environmental costs are even higher. The study also found a divergence in the composition of environmental costs at the two sites, with one spending much more on prevention - and correspondingly less on correction of problems - than the other.

A high proportion of the expenses of Meerssen Papier, a Dutch paper manufacturer, are also environment-related. Costs such as water charges and energy represent 12% of total costs, and in addition there are significant costs of wastes of valuable raw materials (both fibres and colours) at different stages of manufacture. The company already practised sophisticated operational management and costing systems to manage their operations (both process and job costing, as appropriate in different stages). However, in certain crucial stages, these used traditional bases of apportionment such as machine hours and/or output volumes to track costs to products, which did not necessarily reflect the causes of

those costs. An activity-based analysis of their overhead costs was carried out, to generate better bases to track costs to products. This identified some previously unrecognised environment-related cost drivers, for example that small orders and production batch sizes add significantly to waste and other costs; and also that environment-related costs are driven more by heavier than by lighter papers, and more by batches of coloured than of white paper. The case concludes that an ABC approach can be an effective way to integrate environmental management with management accounting. Meerssen plan to use this in managing future changes to their business such as the need to comply with a voluntary agreement with environmental authorities to use recycled paper in their production.

The fourth Dutch case was one of two conducted for the project on the Xerox Company (previously Rank Xerox). In this instance it focused on re-use and recycling of photoreceptor cartridges (Customer Replaceable Units, CRUs). Xerox already has long established processes to deal with returned equipment, driven by the fact that an important part of their products is leased rather than sold to the customer. The central element in these processes is the return to a central Asset Recovery Operation (ARO) located in Venray, the Netherlands.

Because of the Xerox commitment to protect the environment it also initiated the collection of consumables such as photoreceptor cartridges, making use of its existing asset recovery infrastructure.

Depending on the condition of the returned photoreceptor cartridges, the cartridges are either being used for re-manufacturing or reuse of components. For these components, ARO is the preferred supplier of the CRU assembly operation. The internal profit that ARO generates is the difference between the prices of the new components versus the rework cost. However, the gross internal profit margin for the ARO is under strong pressure of increasing costs of disposal, especially for surplus cartridges at the end of the product life cycle.

One of the possible solutions to deal with this problem is to create a fund for future disposal cost by the introduction of an 'end-of-life levy' on new units. This would provide more funds to ARO to fund disposal and give more accurately price signals about the real cost of new units.

1.5.4 The United Kingdom and Ireland

The case on Baxter's health-care products plant at Castlebar, Ireland, involved the development of a site-level equivalent of the company's well-known corporate 'environmental financial statement' (Tuppen, 1996), which attempts to quantify the financial costs and benefits of its environmental activities. The research found that environment-related activities at the Castlebar site generated total benefits of over 1,000,000 Irish pounds during 1996 - almost five times as great as the costs of 210,000 Irish pounds. This was an even better ratio than that for the corporation as a whole. Apart from demonstrating the feasibil-

ity of such an approach at site-level, the case also confirmed the findings of earlier research at Baxter corporate level that the principal benefit of the exercise is the creation of better relationships between the environmental management and other functions (Bennett and James, 1998c). This is a consequence of both the cross-functional interactions involved and the credibility generated by the figures. The site study also corresponded with corporate experience in finding that, although initial data collection was time-consuming, this could be routinised in subsequent years by the amendment of internal data collection procedures.

The UK Xerox case examines packaging initiatives in that company. In particular, the introduction of reusable 'totes' which can accommodate a wide variety of different products has reduced costs by several million pounds annually as well as delivering environmental benefits. The change was devised and developed by a cross-functional Quality Improvement Team (QIT). The QIT undertook a holistic analysis of costs over the whole of the chain, many of which turned out be hidden in sub-chain financial analyses. The research also found mixed messages on the value of conventional accounting systems. Much of the data needed for the cost analyses was not available from the accounting systems, but had to be collected directly from operational sources. However the initial identification of logistics, including packaging, as an area worth review was enabled only due to the systems previously set up to collect and report logistics-related costs across the chain as a whole. Accurate measurement and tracking of this meant that the scale of the challenge, and the potential benefits of improvements, could be assessed, and quantitative targets defined (e.g. to reduce logistics costs from 12-13% of revenue to 6%). One implication is that companies which have developed more sophisticated internal financial reporting systems (such as Xerox's corporate logistics system) are more likely also to have developed support systems whose data can then be used for further purposes. The totes project also raised the endemic management issue of the appropriate balance between central planning and control on the one hand - which was needed in this case to identify the chain-wide opportunities and develop a plan to realise them - but on the other the need to implement changes with care and tact in order to avoid appearing as corporate intrusion which might dis-empower and de-motivate local management. This is more likely if the changes can first be trialled with a limited number of co-operative operating companies before being implemented more widely, as with this project.

The Zeneca case examines 'cost of waste' initiatives at the company's Huddersfield site. Its products are high-performance chemicals produced in multi-stage processes which can generate large amounts of waste in aggregate. Process and product data was collated, and calculations made of the purchase costs of materials discarded in the process and the overall costs of disposing of wastes - with the former turning out to be the major element. The exercise revealed that Huddersfield's 'costs of waste' amounted to tens of million of pounds annually and that there was a potential to save several millions of pounds per annum - much of which has now been achieved. One lesson from the case is that organisational factors are important. A crucial aspect of Zeneca's success was the

location of the Process Technology Department at the Huddersfield site, which gave it day-to-day involvement with site processes and good personal relations with site production staff. The research also found that the success of environmental accounting initiatives is not necessarily reliant on the involvement of the accounting function, since this played little direct part in the Zeneca Cost of Waste project. This was partly because the company found that much of the data it needed for the exercise was already in existence in process records and product specifications. Its main activity was therefore to pull these together and to understand areas where action was likely to be fruitful - a process in which works chemists were especially important.

The case of XYZ (an anonymised term for a real company) focused on the potential relevance of eco-management accounting to product evaluation and its relative usefulness when compared against other assessment techniques. In an action research project, the researchers took a new and replacement product and evaluated them using three different techniques - a costing approach (of both their internal and external environment-related costs), an eco-points approach, and the Dow eco-compass tool. The case study concluded that the key to successful application of all of these techniques was the availability of environmental and cost data across the life-cycle, which was very difficult to obtain in practice. Hence, there is little point in introducing elaborate life-cycle costing techniques until there are cost-effective procedures in place to gather such data. A workshop which brought together different elements of the chain - including equipment disassemblers - demonstrated that the key to this was a process of regular and structured communication between them, rather than only ad hoc initiatives. It also found that all three techniques had differing strengths and weaknesses, which meant that they were best used in combination rather than considered as alternatives. One particular weakness of a life-cycle costing approach was that, even when end-of-life cost figures were available, they proved insignificant when incorporated into discounted cash flow models with high discount rates. However, the case showed that data on externalities is available - and relatively easy to calculate - for transport-related impacts. It also found that it can be a useful piece of 'headline' marketing information, providing that it is not oversold and that the limitations of the calculation methods are understood.

1.6 Implications for the hypotheses

The project's four main hypotheses were:

1. Logical relationships between management accounting and environmental management can be established via the existing production processes and products.
2. The linking of management accounting to environmental management will tend to make it more likely that pollution-prevention measures can be demonstrated to be financially superior to end-of-pipe measures.
3. Firm-based costs resulting from emissions to the environment are often not identified within conventional management practices. As a result, cost savings relating to environmental pressures frequently remain hidden.

4. Activity-based costing (ABC) is a promising approach to remedy the 'black box' nature of overheads. It can be applied so as to systematically quantify the cost-saving effects of environmental measures.

The first of these proved to be unsupported, whilst the other three were broadly supported, although with some caveats.

1.6.1 Hypothesis 1: Establishing logical relationships

Contrary to our expectation, companies with similar methods of production and types of product did not have similar approaches to eco-management accounting. Our survey found considerable variations in practice.

This may be partially explained by our finding that the accounting function was not central to many eco-management accounting activities - more frequently the main drivers were environmental and operational managers. This was related to the importance of operational data such as job and process records to cost reduction and other initiatives. In theory these may be within the remit of management accountants, but in practice - as with Zeneca - this is frequently not the case.

Where linkages were established between management accounting and environmental management they almost invariably took the form of modification of some existing accounting processes, especially investment appraisal.

1.6.2 Hypothesis 2: Enhancing the financial superiority of pollution-prevention measures

This hypothesis was partially confirmed. Several of the cases showed that when hidden costs were revealed they did indeed strengthen the case for waste minimisation and similar initiatives. A majority of survey respondents also felt that this would be the case.

However, the research revealed that the mere identification of costs is not always sufficient to make pollution prevention a financially attractive activity. There are two reasons for this:

- if costs are not allocated to appropriate cost objects or budgets, they will not necessarily influence behaviour;
- if excessively high discount rates are used in investment appraisal techniques, then any long-term costs which are identified will be discounted to negligible amounts.

Later chapters discuss the implications of this.

1.6.3 Hypothesis 3: Identification and allocation of internal environmental costs

This hypothesis was confirmed by the research since:

- only half of the companies surveyed were first identifying and then allocating key environmental costs to processes or products

- a large proportion of both accountants and environmental managers believed that more could be done to identify and allocate environmental costs
- the pilot exercises at Auping and Hercules demonstrated this to be the case for those companies
- the cases where environmental costs had been identified, such as Zeneca and Xerox, are widely acknowledged as exceptional, not least because of the effort expended in revealing hidden costs, and not generaliseable to normal practice in the majority of companies.

Several of the cases, such as Zeneca, also demonstrated that the costs of inefficiency could be the most difficult element of environmental cost to identify, but could also be the most significant.

1.6.4 Hypothesis 4: Potential of activity-based costing (ABC)

The Meerssen Papier case confirmed this hypothesis. However, activity-based costing was being implemented in only 18% of the companies we surveyed (though it was being considered by a further 6%). Moreover, only a small proportion of people interviewed for the project felt that the benefits of introducing eco-management accounting were sufficiently high in themselves to compensate for the high costs of changing accounting systems. Hence, ABC is likely to be only one of the means by which eco-management accounting is being introduced into business.

In addition, we found little evidence that ABC initiatives automatically reveal environmental costs. Substantial inputs by environmental managers and experts will almost certainly be necessary to ensure that this occurs.

1.7 The need for a framework

However, the results of the Ecomac project demonstrate that although many companies claim some eco-management accounting activity, in few if any cases is this being executed systematically and comprehensively. One example of this patchy response was cited by the environmental manager of a major American corporation who reported that his corporation was well aware of the need to carry out thorough environmental checks as part of their 'due diligence' processes when mergers or acquisitions were contemplated, and invested substantial resources (including much of his own time) in this. However this same enlightened awareness was not equally found in other, more internal, processes such as new product development, although (in his opinion) this offered much greater opportunities to generate long-term improvements in environmental performance.

It is also clear from both our research and the literature generally that there are weaknesses - as well, of course, as many strengths - in existing models, such as the well-known total cost assessment (TCA) approach developed in the USA. This is not easily extended beyond its original application in the area of investment appraisal, and hence has difficulty in dealing with important topics such as the costs of inefficiency or revenues

from environmental actions. Perhaps even more importantly, it is based on a premise which empirical evidence suggests is only partially justified (at least in Europe) - that identifying environment-related costs and benefits is the key to generating environmental improvement. However, the findings of research into energy efficiency, that although management may be aware in general terms of many potential investments in this area offering short pay-backs, these may still not necessarily always be implemented in practice, demonstrate that cost/benefit identification is only part of the story (ENDS, 1996; Romm and Browning, 1994).

Hence, there is a need for a more holistic framework which can:

- map the overall relationship between accounting and environmental management and thereby help companies achieve greater consistency in their actions and better integration between functions
- provide guidance on how to modify accounting and related practices in order to drive environmental improvement.

Any such framework has to reflect several factors:

- there are many different reasons for undertaking eco-management activities and many different organisational contexts within which they can be carried out
- most activity will involve changes within existing functional activities, such as environmental management, rather than creating completely new ones
- these changes will encompass both the type of data collected and the techniques used to collect it
- other functions as well as environmental management and management accounting also have an important role to play
- intangible factors such as processes and attitudinal changes can be as important as concrete activity.

Figure 1.7.1 The Ecomac Framework

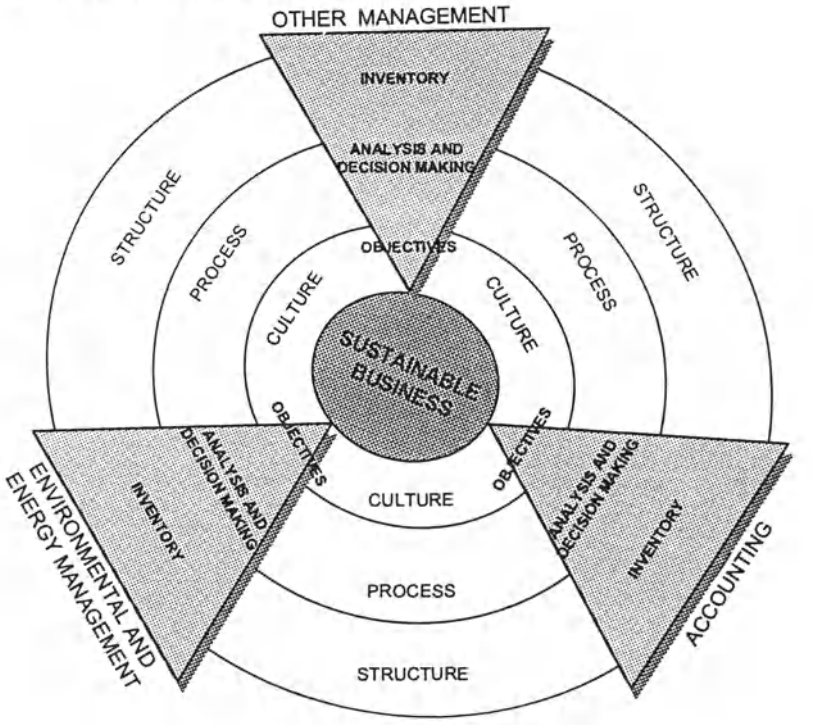


Figure 1.7.1 attempts to capture these points in graphical form. It distinguishes three domains: environmental and energy management, accounting and other management. For each of these there is a hierarchy of three levels:

- the inventory of non-financial and financial data
- the analysis and decision-making techniques which process this data into information which is useful for managers and stakeholders
- the specific objectives of the domain, which are related to the overall strategic objectives of the company.

In addition, the diagram also highlights the importance of three organisational factors - structure, culture and processes - to the practice of eco-management accounting.

The lines which link each domain indicate that a central purpose of eco-management accounting is to break down barriers between them and to provide a greater integration of their activities with regard to environmental issues.

By placing sustainable business at the centre, it also reminds us of the need to go beyond existing business activities and to link eco-management accounting with the broader discussions about sustainable development, i.e. the economic, environmental and social sustainability of an organisation.

A definition of eco-management accounting which captures this is:

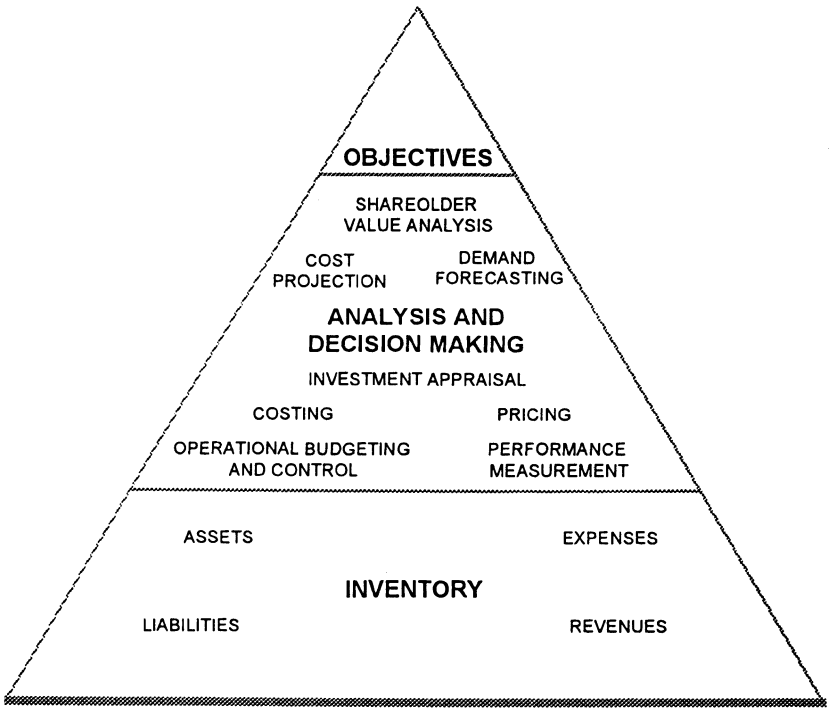
> *the generation, analysis and use of financial and related non-financial information in order to integrate corporate environmental and economic policies and build sustainable business.*

The following sections (1.8, 1.9 and 1.10) discuss the three domains of management and financial accounting, environmental and energy management and other management - and their objectives, data inventory, and techniques - in greater detail. This is followed by a discussion of structure, culture and processes (section 1.11) and finally of sustainable business (section 1.12).

1.8 Accounting

This chapter discusses the existing accounting data sources and techniques (summarised in figure 1.8.1) which can provide inputs to eco-management accounting, the extent to which they take environment into account (or conceal its importance) at present, and possible ways in which they can be modified or supplemented to reflect environmental considerations in future.

Figure 1.8.1 Accounting



1.8.1 Objectives

Accounting is the measurement and reporting of information about the activities and results of an organisation, usually (though not invariably) in quantified and monetary form. It has been defined by the UK Chartered Institute of Management Accountants as 'the classification and recording of monetary transactions; the presentation and interpretation of the results of those transactions in order to assess performance over a period and the financial position at a given date; and the monetary projection of future activities arising from alternative planned courses of action'. It is closely associated with, but distinct from, the *financial management* of business: this is the setting of financial objectives, planning and acquiring the optimum finance to meet them, and seeing that fixed and working capital are effectively managed.

Accounting can be broadly sub-divided into two broad areas - *financial accounting* and *management accounting* - which have somewhat different objectives.

Financial accounting is directed towards *external* stakeholders: shareholders, lenders, government agencies (e.g. taxation authorities), and the community generally. It is required by law, and the content of financial reports is prescribed in detail by law and accounting standards which are binding on all the organisations within their scope. Its purpose is firstly as an exercise in accountability (or 'stewardship') by which the management of an organisation justify their performance to their external stakeholders, and secondly to provide to those stakeholders information which is relevant to the decisions they may face concerning the organisation - for example, for shareholders, decisions on whether to sell or increase their shareholdings.

Management accounting is directed towards *internal* users - the management of the particular organisation, at various levels. The purpose of management accounting is to identify, present and interpret information, both financial and non-financial, to people within an organisation in order to help them to make better decisions and judgements (Drury, 1996).

Eco-management accounting objectives with regard to the accounting domain can be summarised as:

- developing environmental awareness amongst accountants
- taking greater account of environmental issues within specific accounting activities such as budgeting, costing and investment appraisal
- identifying accounting data which could be relevant for environmental management
- helping to develop the scope and depth of eco-management accounting generally.

1.8.2 Data inventory

In theory, management accounting encompasses almost all data within a company, and experts such as Kaplan and Norton (1996) argue that it should make greater use of non-financial data. In practice, however, it continues to focus primarily on financial, and what can be termed neo-financial (e.g. productivity), data. Much of this is also required for fi-

nancial accounting and is therefore maintained within a common system. This is primarily focused on meeting the day-to-day operational needs of initiating and recording transactions, and managing assets and liabilities such as working capital and bank loans. Companies in all advanced economies are also legally obliged to ensure that regular financial reports are made available to shareholders to provide them with reassurance that their assets are being safeguarded and their interests are being met. This is centred on two core reports. The first is the income statement (or profit and loss account), which aggregates expenses and revenues throughout a given financial period (usually a year). The second is the balance sheet (or position statement), which summarises a company's assets and liabilities at a particular point in time (usually at the end of the same financial period). For convenience, we use these four categories of expenses, revenues, assets and liabilities as the basis for our discussion of accounting inventory (see figure 1.8.1 and Bennett and James, 1997). However, before discussing them we need first to define environmental costs and benefits.

Defining environmental costs and benefits

Our research has found that there are at least six different elements which could be incorporated into a definition of costs:

- expenses which are wholly and exclusively required for purposes of environmental protection. This is the definition adopted by most national statistical bodies. The common element in all their definitions is the capital cost of equipment; some include also its operating costs. However, most exclude other wholly environment-related expenditures such as the labour costs involved in environmental management. As the Philips case shows, all of these definitions are too narrow to encompass the full range of environment-related costs
- expenses which are undertaken for both environmental and non-environmental purposes so that only a proportion count as environmental expenditures
- the costs of inefficiency, i.e. sub-optimal utilisation of environmental resources such as energy, raw materials or water. The amount of environmental cost is then the difference between the cost of the quantity which is actually consumed, and a hypothetical lower level which could be achieved with better environmental or energy management.
- intangible costs such as damage to reputation, which are difficult to quantify
- external costs, i.e. welfare costs to society, which are not reflected in the company's own transactions or accounts
- opportunity costs, i.e. welfare losses associated with foregone alternatives - in this case too little or no environmental action.

Similarly, environmental benefits could encompass any or all of:

- additional revenues arising from environmental actions, e.g. the sale of materials recovered as a result of recycling
- intangible benefits arising from environmental actions, such as enhanced reputation
- savings of raw materials and other inputs resulting from preventative measures

- costs avoided as a result of environmental action, e.g. through better utilisation of energy and materials, or by preventing the need for pollution-control expenditure through waste minimisation schemes
- reduction of environment-related risks.

The discipline of management accounting has a maxim of 'different costs for different purposes', which is based on a recognition that cost and benefit data is context-dependent and that a single definition is therefore impractical. Our research suggests that this maxim is equally valid for the field of eco-management accounting and that a single definition is equally unlikely overall. However, it is clear that there are some areas - such as corporate reporting of environmental expenditures - where consistency is important and some action is needed.

Expenses and revenues

The basic accounting systems within organisations (the bookkeeping systems and ledgers) will generally capture and collate expenses in terms of a combination of two parameters:-

- the type of resources being acquired and consumed: materials, labour, services, depreciation, etc.
- the functional area of the business in which the expenses are incurred: production, selling and distribution, general and administrative, etc.

These classifications reflect the sources of the data in the various sub-systems of a normal business accounting system. Two categories of particular environmental relevance are purchasing records and payroll data. In the SGS-Thomson case, for example, the source of much of the data needed to substantiate the extent of hidden environmental costs was extracted from purchasing records. The Auping and Hercules cases also demonstrated that the largest single element in the environmental costs identified was that of labour spent on environmental activities.

Except in very specific cases - for example, income from sale of recycled materials - it is difficult to estimate the impact of environmental factors on revenues, as they are only one of a number of factors influencing them. However, they can be significant and some believe that environmental influences on the market place will prove to be the biggest 'bottom line' impact of all in the longer term (DeSimone and Popoff, 1997).

Reclassifying accounting data after its initial entry is sometimes impossible and almost always time-consuming and costly. Hence, the secret of success in all areas of accounting - including that related to environmental issues - is to capture any information necessary for analysis (such as the purpose of expenses) when the data is first captured and recorded. However, modifying existing systems can also be costly. The lowest-cost option is to build in environmental considerations when systems are being changed for other reasons - for example, because of a move to activity-based costing (ABC - see below) or

an enterprise resource planning system such as SAP, Oracle or Baan (see section 1.10.3). A key task for eco-management accounting is therefore to ensure that the needs of environmental management are considered when changes are being made. There may be an opportunity to obtain better quality data, but almost equally important is to avoid a deterioration in the quality of existing data. In one company which we researched, a re-engineering exercise resulted in previously separate categories for energy purchases - electricity, gas, etc. - being collapsed into a single energy category. As a result, it lost the ability to use the data in its accounting system to help it to calculate easily its energy-related carbon dioxide emissions.

Assets

Accountants identify three broad categories of assets - fixed (or long-term) assets, current assets, and goodwill (a particular type of long-term asset). Fixed assets are those with a useful life beyond a single accounting year, and data on them is collated in a register of plant and equipment. Fixed assets are (with some exceptions) stated in the balance sheet at their original historic cost, reduced by depreciation provided to date in respect of the portion of their useful life which, to date, has expired. The high cost and long life of assets such as pollution-control equipment and landfill sites means that these can be significant fixed assets. There are variations in practice over the basis on which environmental fixed assets are included in environmental costs: some definitions include the initial expenditure at the time of purchase, others instead include the depreciation arising over their working lives.

An alternative method of valuing fixed assets is at their replacement cost. This is of potential environmental significance because rising environmental standards often mean that the cost of building new environment-related facilities is much higher than those which are replaced. This is the case with landfill at Zeneca's Huddersfield site. The company has a long-standing site which is fully depreciated. Hence, only operating expenses are charged back to product and process cost centres. As the site has many years' life this can be practically justified but, at current rates of waste generation, a replacement landfill facility will have to be built at some point. This is likely to be very expensive and will therefore result in an immediate increase in recharged costs as depreciation is included in the figures. However the conventional method of basing these re-charges on historic costs means that managers who take decisions which affect the volume of wastes generated, through process control and product design, are not encouraged by the system to take into account also the opportunity cost which is indirectly incurred as landfill capacity is consumed.

The main current assets for most companies are cash balances, debtors (accounts receivable), and stocks and work in progress. Although environment has some tangential relevance to these - changes in environmental legislation could result in stocks becoming more difficult or impossible to sell - this is not usually a major area of concern.

Goodwill is an asset with whose treatment the accounting profession has been struggling - with only limited success - for some time. Conventional accounting practice recognises and includes goodwill in company balance sheets only when money is directly outlaid to acquire it, when one company is purchased by another. The goodwill then arising is the amount by which the purchase consideration exceeds the value of the tangible net assets acquired, and represents what the acquirer is prepared to pay for the present value of the amount by which the acquired company's future profits are expected to exceed a normal rate of return. However, this basis necessarily ignores any internally-generated goodwill which has built up within the business as a result of operating over time and building up a reputation amongst customers, since this is not represented by any specific outlays and is therefore not captured by the accounting system. Several studies have suggested that environment is an important determinant of company reputation, although the precise extent of this is difficult to quantify.

Liabilities

Liabilities can be distinguished by type into three broad categories: sources of finance, liabilities arising from normal operations, and provisions.

In most major corporations the raising of finance and the balancing of debt and equity is handled within the finance function by a treasury management function, which is separate from the financial controlling activities of then allocating, managing and accounting for this finance within the business. Environmental performance is increasingly significant for treasury management since the extent of risks being borne by a company, including those which are environment-related, can affect access to and the cost of raising new capital. Several studies have shown that the shares of companies with good environmental records have out-performed the market average - thereby lowering the cost of raising capital - and, conversely, that those of companies which have experienced major environmental incidents have been depressed, making new capital more expensive (Blumberg *et al.*, 1997). Kvaerner, for example, has paid slightly lower interest rates on loans because of its good environmental record and consequently greater creditworthiness. Some analysts and insurers are coming to see evidence of good environmental management by a company as indicative of the quality of its management generally.

Liabilities arising from normal operations include trade and most sundry creditors, corporation tax due, and tax collected but not yet paid over in connection with PAYE and VAT, etc. These may be affected by any events occurring within the business, including environment-related, but are unlikely to be particularly significantly affected by environmental management.

Provisions are amounts allocated to cover any probable (or certain) future liabilities or losses which have arisen but have not yet been settled (provisions included under 'liabilities' will exclude any provisions in connection with the impairment in value of assets, such as arising from depreciation or the obsolescence of inventories, which will be reflected in

the balance sheet as a reduction in the value of those assets). There is considerable concern that significant liabilities could exist, in respect of (for example) remediation or future de-commissioning costs, which are frequently not fully provided for in company financial reports. Until now the emphasis has been on quantifying liabilities arising from past events but, whilst this remains important, Brent Spar and other developments have focused attention also on potential future liabilities.

1.8.3 Analysis and decision-making techniques

The second tier of the pyramid in figure 1.8.1 identifies the main accounting techniques which are used to process the information arising from the financial and non-financial information systems for management's benefit - performance measurement, operational budgeting and control, costing, pricing, cost projection, demand forecasting, investment appraisal and shareholder value analysis. All of these are actually or potentially relevant to environment. One important distinction is between those which are concerned with current data and those (broadly cost projection, demand forecasting, investment appraisal and shareholder value analysis) which are making projections into the future. Following chapters discuss the environmental relevance of each of these techniques.

1.8.4 Performance measurement

Performance measurement is a growing field in all areas of business. Traditional performance measurement in the UK and USA has focused on meeting financial targets, particularly at higher levels of management. However, over the last decade the quality movement and other drivers have focused attention on the importance of non-financial performance measures, and schemes such as the European Quality Award and Kaplan and Norton's 'balanced scorecard' now provide templates for this (Kaplan and Norton, 1996). These developments have - together with other factors such as regulatory requirements and demands from external stakeholders - led to the rapid development of environment-related performance measurement (Bennett and James, 1998a; Epstein, 1996). As previously noted eco-management accounting could, in principle, have an important role in this area - although one study found little evidence of this happening in practice (Bennett and James, 1998a). Its main environmental implications in the immediate future are likely to be in ensuring that financial performance measures reflect environmental considerations - for example, by ensuring that environmental costs are identified and allocated to budgets.

Operational budgeting and control

The setting of budgets is an important means of implementing strategic objectives, whilst tracking budgetary outcomes can be a valuable means of tracking how well objectives are being achieved. Budgeting is relevant to environmental management for three main reasons. Firstly, environmental actions will require resources which need to be specified within budgets. Secondly, budgetary outcomes can be a useful means of checking

whether environmental goals are being achieved - for example, over-budget expenditures on energy provide an early warning that energy targets are unlikely to be achieved. Finally, as previously noted, identifying and allocating environmental costs to specific budgets provides a powerful incentive for action to be taken.

Costing

Four important areas of costing are:

- activity-based costing
- quality costing
- product costing.
- externalities costing.

One general point which emerges from several of the cases is the danger of relying on historic cost data. New environmental regulations - such as those related to packaging disposal - or other pressures can create much higher levels of cost in future which need to be taken into account in current costing activities.

Activity-based costing (ABC)

As noted in sections 3.5 and 3.6, ABC is an important component of eco-management accounting. In traditional costing systems, overheads are usually allocated to products and processes on the basis of simple formulae such as production volume or head count. ABC tries to create more meaningful cost information by tracking costs to products and processes on the basis of the underlying 'cost drivers' which cause those costs to be created in the first place. The amount of cost lost in overheads is thereby greatly reduced. As a result, product prices can be set more accurately, and significant cost drivers can be targeted for cost reduction measures. Where environment is a significant cost driver, it should be highlighted naturally by ABC activities. However, there is usually considerable scope for more proactive environmental concern, either by building a more detailed picture of environmental cost drivers and categories where these have already emerged as important, or by highlighting them when this is not the case (Kreuze and Newell, 1994).

Quality costing

The rationale of this approach is to highlight the costs of non-quality in order to develop motivation to reduce them and prioritise possible actions. Conventional quality costing distinguishes three types of costs:

- failure - the costs of putting right or otherwise dealing with defects, whether as a result of internal failure or of external failure, as when defects in products become apparent when in use by customers
- monitoring - inspection and other costs to ensure that defects are eliminated or detected
- prevention - costs of avoiding defects.

The finding from cost-of-quality studies is frequently that, in the long run, the costs of prevention are far lower than those of monitoring and failure. Without the studies this might not be apparent, since failure costs include several which are intangible and/or incurred at points in the operational chain at some distance from where the loss in quality occurred.

Diependaal and De Walle (1994) have developed a specific quality costing approach - termed 'model of environmental costs' (MEC) - which formed the basis of two of the Dutch case studies. This model sub-divides failure costs into internal failure costs and external failure costs - to reflect whether the activities which create costs are undertaken within the site or to remediate external environmental problems - and replaces monitoring with correction costs. The latter is sub-divided into process-integrated correction costs, which are adaptations and adjustments of processes, and effect-mitigating prevention costs, which is end-of-pipe treatment. The Ecomac studies confirmed their initial analysis that, on the MEC definition, environmental costs account for around 2% of the costs of an average Dutch company.

One conclusion is that, to be valuable in the environmental field, failure costs probably need to be defined more broadly so that they include what might be called indirect failure costs or the 'costs of inefficiency', i.e. the costs of purchasing and processing materials and energy which end up as waste. Several studies have found that these costs of inefficiency can outweigh other environmental costs, especially in Europe where the liability costs associated with accidents or contamination are less onerous than in the USA. The German textile producer Kunert, for example, has calculated that its costs of inefficiency amount to around 10% of turnover.

Product costing

Producers need accurate information about the cost composition of their products in order to determine prices and to identify cost reduction opportunities. Users need data about the total costs of products they are buying in order to compare alternatives which have different proportions of acquisition and operating costs. Designers need both types of information in order to create products which have reasonable purchase and running costs. Environmental costs are important in all these cases and there can be detrimental consequences if they are not properly identified and allocated.

For producers, it is not uncommon for a small number of products to generate a large proportion of emissions or wastes. This was demonstrated by several of the Ecomac case studies - for example, at Philips' Aachen glass factory where one third of the processes were generating all of the waste treatment costs. It has also been confirmed by other studies (for example, Ditz *et al.,* 1995). However, environmental costs are often not allocated to individual products but treated as a general overhead. Even when allocated, this can sometimes can be on the basis of formulae which bear no relationship to real cost drivers - as with Philips where the costs of waste treatment were allocated on the basis of share of overall production, even though two thirds of output did not actually require the

activity. In either of these situations, clean products will appear to have higher costs than is actually the case while dirty products will appear to be cheaper to produce than they really are.

Life-cycle costing takes this further by seeking to identify all the costs incurred during the whole life of a particular product (or system). Environmental costs can be a significant element in the total cost of buying, using and disposing of a product. It can therefore be sensible to identify and calculate these at the time of purchase. Two particular areas which a number of organisations have started to examine are the costs of dealing with emissions or wastes from operations, and of disposing of products at the end of their lives. Gaining a better understanding of these costs - as with the model which Philips has developed to consider end-of-life disposal costs (Brouwers and Stevels, 1997) or the case of the Xerox packaging reduction exercise studied for this project - allows timely action to be taken to minimise or avoid them through redesign and/or to put more cost-effective disposal routes in place.

In practice, however, end-of-life costs can be difficult to obtain, as the XYZ case study demonstrates. This concluded that there is a danger in this area (as in some others of eco-management accounting) of being tempted to introduce over-sophisticated techniques at too early a stage (of 'trying to run before you can walk'). What is important is rather to develop a good inventory of life-cycle impacts and costs before sophisticated techniques are applied to them. It also found that, even when end-of-life costs can be identified, they can often seem unimportant to a decision which is based on a net present value model which uses an excessively high discount rate, because this will report benefits which arise only at some distance into the future as having only a minimal present value.

Externalities costing

This seeks to quantify the costs to society of a company's activities which are not internalised within its own accounting system. There are a number of reasons why organisations might wish to calculate the externalities created by their processes or products:

- to demonstrate that a particular product, process or activity does not create major externalities or that it creates less externalities than do the alternatives. This is one of the objectives of both XYZ (see section 4.4.4) and of one of the pioneers in the field, Ontario Hydro, which sought to demonstrate that its overall externalities were not large and that those associated with its nuclear power stations were particularly low (EPA, 1996).
- to inform decision-making by allowing comparisons between the externalities created by different options. This has been a driver at Ontario Hydro, which has used externalities data to compare different electricity generation alternatives.
- to identify possible sources of future costs and responsibilities. Environmental legislation and market forces encourage (and in future will increasingly encourage) compa-

nies to internalise external costs and to extend their responsibilities along the product life cycle.

Economists have developed a number of techniques for costing environmental externalities and many calculations have been made, particularly in the areas of energy and transport (for example, European Commission, 1995; Oak Ridge and Resources for the Future, 1992-96). However, the figures generated tend to be controversial, for three reasons:

- the calculations are based on data which at times is, by its nature, uncertain and subjective;
- business managers may question whether it is appropriate to consider costs which by definition do not currently have to be met by the company;
- others may question the implications of 'putting a value on the environment'.

In some ways the debate is academic since neither our study nor others (for example, Tuppen, 1996) have found any evidence that the approach is having a significant influence on corporate decision-making. However, this could change in future, particularly for organisations and activities with highly visible external costs. The project's XYZ case study also found that externalities data could be potentially useful for marketing purposes.

Pricing

Pricing requires consideration of customers and competitors as well as costs, so accounting techniques are only one aspect. However, adequate cost analysis is an essential part of pricing decisions, which may be distorted by any inaccuracies in costing systems.

Life-cycle costing provides a framework to consider costs incurred not only within the organisation itself but also along the product chain, i.e. upstream (by suppliers) and downstream (by customers and consumers). This can help to identify opportunities where modest extra spending by the company may disproportionately increase value for the customer which can be reflected in an increased selling price and/or increased sales volume. As our case demonstrates, Baxter International has generated substantial savings in materials costs for itself through packaging re-design. As well as this benefit, reducing the quantity of packaging of which the final user has to dispose is becoming an increasingly significant selling point in countries with strict legislative controls such as Germany.

Cost projection

The accurate projection of future costs is important for both investment appraisal and other purposes. Environment can be an important determinant of these future costs. This is highly visible with new legislative or regulatory demands, and forward-looking companies will also be considering the potential costs of possible future legislation or other environment-related changes which could impact on the business. One indication that this may happen is when costs in one country are much lower than in others; another is when there are significant externalities (see above). Companies making capital investment and

other decisions with long-term financial consequences might be wise at least to consider the implications of these.

Demand forecasting

Environmental factors are already having an influence on many markets which is likely to increase in future. This influence takes two forms - the volume of a product or a service which can be sold and the price at which it is sold.

Sales volumes of a number of products - for example, CFCs - have already been largely or completely curtailed by law as a result of environmental considerations and the likelihood is that more will be withdrawn from the market ('sunsetted') in future. Customers may also discriminate against products with poor environmental performance, especially if better performing ones offer similar value.

Sunsetting and other environmental developments also create opportunities for new products. Indeed, it may be that the revenue streams from future eco-efficient products - i.e. those which offer both greater customer value and improved environmental performance - will have a greater impact than any of the other areas discussed in this chapter. However, it is not usually possible to do more than guess at the amounts of potential future revenues from hypothetical new products, and consequently less attention has been paid to this area in the environmental accounting literature than to methods of cost analysis.

Capital budgeting/investment appraisal

Organisations must decide the total and composition of their capital expenditure - a process known as capital budgeting. Many organisations which are committed to compliance with environmental legislation may find that stringent environmental regulation requires them to make substantial expenditure on pollution control and other environment-related projects without any obvious commercial return. This can considerably increase total expenditure and/or 'crowd out' discretionary investments which might be profitable.

The Ecomac project - and other research - suggests that the appraisal of individual capital investments can pay insufficient attention to environment in four main ways:

- Inventory - there may be 'hidden' environment-related costs or benefits which could influence cash flows if identified
- Time scale - by effectively ignoring substantial environment-related cash flows over the medium-long term
- Risk - by under-estimating the possibility of environmental opposition or other environment-related factors affecting cash flows, particularly from large-scale projects
- Strategy - by locking into technical approaches which may make sense on a one-off basis but which in practice can lock a company into a continuing stream of investments whose environmental costs might increase greatly with time.

Inventory

Sections 1.2 and 1.3 provided evidence on this point, which was reinforced by many of our case studies (see section 1.5). One particularly interesting case was that of Italiana Petroli, which found that the inclusion of estimates of future potential liabilities into a cost-benefit analysis of whether to proceed with pollution-prevention measures at some of its petrol stations turned them from apparently unprofitable into profitable investments.

Many of the hidden costs identified in the cases replicate other discussions. However, our research one important aspect which has been little discussed, which is the relationship between a new investment and the existing environmental management infrastructure. Investments often rely on an existing infrastructure of energy and water supply, water treatment and pollution-control facilities, etc. which, even when costed, is done on a short-term and/or marginal cost basis. This may be misleading. In one company an additional waste stream from a new investment unexpectedly interacted with existing ones to create a new problem which was expensive to remediate. It may also be that the existing infrastructure could be downsized or removed through pollution-prevention initiatives - introducing a new existing waste stream could prevent this from being achieved. Finally, the infrastructure may need to be replaced whilst a new investment is still operating - in which case, it might be appropriate to introduce an estimate of the cost of these into the investment calculations.

Time scale

Pay-back appraisal methods do not consider cash flows beyond the pay-back period. Discounted cash flow methods (Net Present Value and Internal Rate of Return) do so in theory, although in practice this is not always effective if excessively high discount rates or target rates of return mean that cash flows which are more than a few years after the start of a project are effectively being discounted to low or near-zero values.

This short-term bias makes immediate business sense but does mean that many investments which can provide a long-term stream of environmental benefits (or reduced environmental costs) but which have high short-term costs are given equal ranking to projects with similar financial characteristics but no long-term environmental positives. Moreover, the value of such benefits is likely to increase with time. One example we came across was of an investment which delivered an order-of-magnitude greater reduction in carbon dioxide emissions compared with another alternative but was initially rejected because of a small difference in financial return.

Appraisal techniques can be adapted to take these points into account by applying lower or higher discount rates to environmentally significant investments, or for long-life projects by extending the period for which future benefits are considered beyond the usual truncation point. However, this may reduce the credibility of the results for business managers.

Risk

None of the methods takes risk into account - could unexpected environmental regulations, protests, etc. influence the costs and, to a lesser extent, revenue streams of investments? Two companies in our study were considering this in relation to PVC in their products - its economic advantages compared to other plastics was not great but, if environmentalist campaigns against it are successful, the potential business risks of redesigning products, retrofitting installations and being portrayed as placing many people in contact with a potentially hazardous material began to seem considerable.

Strategy

Investments influence the future strategic position of the company. For example, if a vehicle company makes a substantial investment in a new plant to make internal combustion engines it is less likely to consider alternative engine technologies and is also more committed to being a manufacturer of cars that, say, diversifying into becoming a provider of transport services.

In conclusion, environmental factors can be significant in determining the ultimate returns from new investment. It is therefore important that they are identified and considered during the early stages of investment decision-making. This not only allows major problems to be avoided but also provides an opportunity for remedial action at a stage when the costs of doing so can be relatively low. Although many companies are currently bringing environment into capital budgeting by requiring qualitative assessments of impacts arising from major investments they may need to go further in future.

Shareholder value analysis

In recent years there has been an increase in interest in measuring shareholder value, especially in countries where the capital markets are a particularly strong factor in the economy as a whole, such as the UK and USA. This has in part been in recognition of the principle that in many countries (and so far as capital markets are concerned), the overriding priority for a company, reflected in law, should be to provide benefit for its equity investors, and also in part as a correction for what are often perceived to be the deficiencies of conventional measures of accounting profitability as the main indicator of business performance.

The term is often used only loosely, but, when used more exactly, defines shareholder value as the present value of a company's future cash flows, discounted at an appropriate rate. As environment can affect all of the main parameters in this equation - future expenses, revenues and cost of capital - it is therefore an important element to be considered in any calculations (Schaltegger and Figge, 1997). Demonstrating that environmental-related costs and revenues can have a significant influence on shareholder value can also be a useful way of gaining senior management attention and creating pressure for action from external stakeholders.

1.9 Environmental and energy management

1.9.1 Objectives

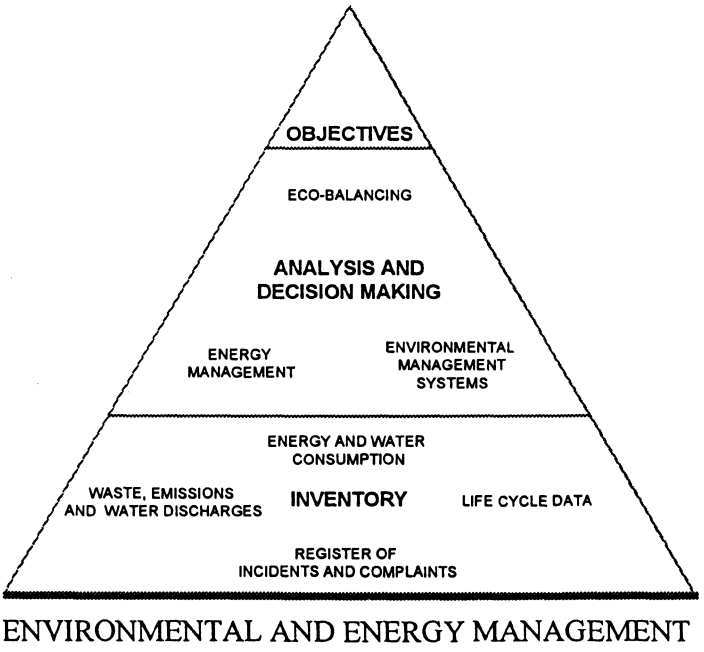
Energy management has the objective of minimising energy costs and energy-related environmental impacts. Although in principle this is a separate activity from environmental management, in practice there is close interaction between the two activities and many companies place them within the same department. For this reason they are discussed together here.

Section 1.2 has discussed some of the general objectives of environmental management. The specific eco-management accounting objectives of this domain can be summarised as:

- improving the financial literacy of environmental and energy managers so that they can make better business cases for environmental action and/or better understand the needs of external financial stakeholders, internal accountants, and financial managers
- providing specific data on environment-related costs and risks as inputs to accounting processes
- making greater use of data from accounting systems within environmental management
- helping to develop the scope and depth of eco-management accounting generally.

Figure 1.9.1 outlines the main data sources and techniques within this domain which are of relevance to eco-management accounting.

Figure 1.9.1 Environmental and energy management



1.9.2 Data inventory

Much environmentally-relevant data is actually 'owned' by other functions than environmental management. However, some potentially valuable sources of eco-management accounting data which are often located or collected within the domain of environmental management are:

- waste, air emissions and water discharges records
- energy and water consumption records
- register of incidents and complaints
- life-cycle data.

Waste, air emissions and water discharges records

Waste records represent probably the most sophisticated environmental bookkeeping system within the industrial sector, due to the increasingly stringent legislation that has been in force in all developed countries for several decades. Legislation frameworks in EU countries, while presenting some differences, generally require companies to be accountable for:

- the quantity and types of wastes produced (distinguishing between toxic and non-toxic wastes)
- providing information on the destination of the final disposal of wastes, including on waste disposal contractors whose services may have been used.

A number of countries also require companies to disclose their emissions of specified hazardous materials. The best known example of this is the US Toxic Release Inventory (TRI) legislation, issued under the SARA Title III, which has had a major influence on how American businesses - and, in many cases, their European subsidiaries - maintain records of wastes and make disclosures. The TRI requires companies to account for releases of more than 300 toxic components, and to report annually to competent bodies. The combination of the disclosure of TRI data and 'right to know' legislation has generated a large amount of data which has been valuable to support comparisons between both industry sectors and companies - for example, with regard to turnover per unit of toxic chemical emitted.

Since much of eco-management accounting is concerned with assessing the complete costs of emissions and wastes to a company and finding ways to reduce them, such data is a key resource. Some key questions are whether sufficient data is being collected, the means by which this is being achieved (e.g. whether by estimation rather than by direct measurement), and its reliability.

The costs associated with wastes, air emissions and water discharges are also likely to increase in future at rates in excess of general inflation under the joint pressures of market forces (e.g. diminishing landfill capacities) and of government policies such as the UK

landfill tax. Moves towards economic instruments as an alternative to command-and-control methods of regulation, such as through tradable 'pollution permits', would accentuate this. This will mean that good environmental management and information will become increasingly relevant for cost management generally. Conversely, the accounting function can assist environmental management through its data collection procedures - if the accounting system is designed to record physical quantities of wastes, etc., distinguished between different types, as well as the financial costs which are incurred on their disposal, this will then facilitate the collection and reporting (both external and internal) of environmental information.

Energy and water consumption records

Energy is financially costly - particularly in Europe - and its production, distribution and use has considerable environmental impacts. Hence, accurate data on the scale and pattern of consumption is important because it:

- helps to build a picture of the organisation's overall environmental 'footprint'
- helps to determine the degree of priority which should be given to energy management
- provides the starting point for allocating energy costs to budgets or cost objects
- can potentially enable discounts to be negotiated with suppliers.

The two primary sources from which data for overall energy consumption can be derived are the metering of inputs, and supplier invoices. Comparing them can be useful because discrepancies often occur and can result in rebates, and/or in more accurate bills being provided. Our interviews suggested that aggregate figures are often compiled only as a result of action by environmental managers seeking data for environmental reports or other purposes.

Growing public concern about the 'greenhouse effect' has also led some companies to take into account, as well as cost savings, the impacts on the environment associated with their consumption of energy, including in particular the implications of the different possible original sources of energy (for example, whether renewable or non-renewable). As a result, it is becoming more common for European industrial companies to measure and report on their energy consumption distinguishing between different sources, and identifying the CO_2 emissions related to on-site electricity production. This may also be a statutory requirement in future.

Even when overall energy consumption is known, detailed breakdowns are often unavailable even though this is essential for good energy management (see discussion in the 'Analysis and Decision-Making Techniques' section below). Hence, one of the first steps of eco-management accounting should be to consider whether more should be spent on metering and monitoring energy consumption.

The cost-related incentives to account for water consumption have not been so strong as for energy. The cost of water varies widely between different European countries and is

not always related to actual consumption. However, the general trend is towards rising prices and a direct relationship between price and consumption. Hence, there is the same need as with energy for detailed data on the scale and pattern of consumption.

In the case of both energy and water, the accounting function can again support good environmental management by designing the financial data collection system to collect not only financial data on costs and revenues associated with energy and water but also the underlying physical quantities. Changes to mainstream accounting systems are infrequent and major events, and it is expensive and usually impractical to attempt to make minor modifications. However, the occasional major revision of a system, or replacement of an old system, provides an opportunity for environmental managers to have an input into how the new system is designed.

An example of the potential for this was provided in one company surveyed, where the opposite had happened and information was lost. The company had undergone a business process re-engineering exercise, in which the environmental manager was not involved, and which resulted in the condensing of what had previously been a number of separate energy codes (for each of electricity, gas, oil, etc.) into a single code. This made it more difficult not only to track energy consumption in detail but also to generate data on carbon dioxide emissions from fuel combustion, which will almost certainly be needed for environmental management purposes in future.

Register of incidents and complaints

The law of many European countries requires their companies to maintain a Register of Incidents. The aim of this is to record all relevant information related to specific defined incidents, such as chemicals spills, in order to enable company management to anticipate future events and to be accountable to external stakeholders. Many companies also choose to do this for internal reasons. Many also maintain a register of environment-related complaints. Both types of data are potentially useful for supporting judgements on potential liabilities or effects on operating costs or revenues. Complaints about airport noise, for example, are a key issue for airports - too many can result in restrictions on night flights and other activities, and consequently either reduced income or a need to spend on noise reduction measures.

Life-cycle data

Life-cycle data is important in assessing environmental costs at all stages of the product chain and particularly those - such as end-of-life disposal costs - which are out of the direct control of manufacturers (see section 3.10.3). The obvious sources for such data are the procurement function in the case of suppliers, and the product development and marketing functions in the case of customers. However, as the Sony and XYZ case studies demonstrate, this seldom occurs at present so that the generation of necessary data is

typically initiated by the environmental management function (although, once established, the responsibility for routine data collection may well then pass to other functions).

The most complete means of collecting such data is through a life-cycle assessment. ISO 14040 defines this as 'a technique for assessing the environmental aspects and potential impacts associated with a product, by

- compiling an inventory of relevant inputs and outputs of a system;
- evaluating the potential environmental impacts associated with those inputs and outputs;
- interpreting the results of the inventory and impact phases in relation to the objectives of the study.'

The assessment includes the entire life-cycle of the product, process, or activity, encompassing the extraction and processing of raw materials, and their manufacturing, transportation and distribution; and the use, re-use, maintenance, recycling, and final disposal, of products.

LCA data has financial relevance in two main ways. The first is in identifying impacts which create, or could create, internal costs for an organisation and/or its customers. The second is identifying impacts which create significant external costs to society. This can be a useful guide to prioritisation and, if the trend is towards internalisation of these costs, can also provide leading indicators of future cost drivers.

However, LCAs are expensive in both resources and time, and seldom deliver universally accepted findings. Hence, simpler and cheaper methods are needed to generate life-cycle data which is of potential financial relevance. For upstream data, the normal method is a questionnaire, which is usually undertaken in collaboration with procurement departments. Collecting downstream data is more complex and usually requires collaboration with marketing and customer service departments (see Section 1.10).

1.9.3 Analysis and Decision-making Techniques

The most commonly used environmental management instruments for analysis and decision making are:

- environmental management systems
- energy management
- eco-balancing
- risk assessment and rating.

Environmental management systems

As section 1.2 discussed, many organisations are now applying quality principles - and particularly that of continual improvement - to environmental management. This involves a shift from a mentality which focuses solely on compliance with regulation, to one which

identifies broader opportunities to ameliorate environmental impacts. The process of continual improvement is frequently simplified into four stages - plan, do, check and act:

- *Plan* involves the identification of key customers and stakeholders, identifying opportunities for improvement and the development of programmes to achieve them
- *Do* is the implementation of these programmes;
- *Check* is the monitoring and reviewing of progress, wherever possible against quantitative targets;
- *Act* involves changing, if necessary, existing programmes and using the learning from them to begin the cycle again with new plans.

This plan-do-check-act process forms the basis of the two international options for external registration of environmental management systems (EMS) - the Eco-Management and Audit (EMAS) scheme of the European Union, and the International Standards Organisation's standard, ISO 14001. The main differences between these are that:

- certification to ISO 14001 can be gained in any country, for any organisational level - site, division or the entire organisation - in any sector whereas EMAS focuses only on sites, and only within the European Union
- ISO 14001 has no provision for public disclosure of information - which some of its critics see as a major weakness - whereas EMAS requires an environmental statement to be published in respect of the site.

As the management system requirements of both standards are similar - and as there is a greater international take-up and recognition of ISO 14001 - we adopt its terminology here.

Plan

ISO 14001 identifies two main plan stages - policy and planning, with the latter having four sub-divisions involving

- consideration of environmental aspects
- consideration of legal and other requirements
- setting of objectives and targets in the light of previous actions
- establishing an environmental management programme to achieve the objectives and targets.

Consideration of environmental aspects usually requires assembly of a great deal of data, some of which - such as invoices detailing resource consumption - will be located within accounting systems. In addition, a key outcome of the exercise is the identification of the most significant aspects - an exercise which is often based on their business as well as their environmental significance. Knowledge of the financial costs and benefits created by the aspect is therefore extremely important. It is also relevant to the next steps of setting objectives and targets and introducing an environmental programme. Experience suggests that actions creating a net financial benefit are both the easiest to achieve and also

of great importance in demonstrating that the system can create positive benefits for the organisation.

Conversely, a good understanding of environmental aspects and their relative significance is an important requirement for introducing environment into accounting processes such as investment appraisal. When this has been undertaken as part of introducing an EMS, then accountants will not need to repeat these procedures (to 'reinvent the wheel').

Do

ISO 14001 terms this stage *implementation and operation*. It has seven sub-divisions:

- structure and responsibility
- training, awareness, competence
- communication
- EMS documentation
- document control
- operational control
- emergency preparedness/response.

All of these need to be implemented within the accounting function itself - for example, through formal records that environment has been considered in important activities such as investment appraisal. More broadly, development of data on the financial costs and benefits of introducing an EMS can be an important element in building commitment and ensuring that the system implementation is successful.

Check

ISO 14001 terms this *checking and corrective action*, which has four sub-divisions:

- monitoring and measurement
- checking and corrective and preventative action
- records
- EMS audits.

Accounting competences such as performance measurement and auditing are obviously relevant here. Accounting data - such as energy invoices - can also be of importance in monitoring and measurement.

Act

ISO 14001 refers to this as *management review*. It involves assessing the outcomes of the plan-do-check stages and then beginning the cycle anew with fresh objectives. Consideration of the financial costs and benefits will be an important element in this activity.

In the light of the above, it is not too much of an exaggeration to say that an environmental management system is unlikely to deliver its full potential unless it is based upon and develops further linkages between the environmental management and accounting functions.

The ultimate ideal of an environmental management system is to have an integrated on-line information system which contains all relevant data, including that from accounting and operational sources (Fitzgerald, 1997). However, no companies have yet achieved this and the costs can be considerable. One computer company we interviewed had tried to develop such a system both for its own use and as a commercial product but found that the costs of doing so were twenty times greater than building a stand-alone system which was updated manually as and when required. It was felt that the benefits to be obtained from an integrated system were not sufficient to offset the additional costs.

Energy management

In many cases, energy management is combined with environmental management but in others the functions can be separate. Predictably, energy accounting and management are most well-developed in countries where energy costs are relatively high, and the main drivers which historically have encouraged companies into energy management and efficiency programmes have been economic rather than environmental. Today, energy management and environmental management are closely aligned since increasing legislation and targets set by governments (for example, those arising from the Rio and Kyoto summits), together with pressure from stakeholders, are pushing companies to increase their energy efficiency, and to decrease their energy consumption and the associated environmental impacts such as emissions to air.

Energy efficiency experts report that although it is frequently a significant cost item, many companies still do not have a coherent energy management system. Consistent with this, energy costs are often treated as an overhead and either written off as a period cost or apportioned to processes and products on general bases which do not reflect their causes. This provides little or no incentive for middle and junior management to control energy consumption and costs in their areas of responsibility. Accountants can therefore play an important role in supporting energy management through:

- ensuring that responsibilities are properly defined and adequate controls are in place
- providing necessary data on energy consumption and costs, analysed as appropriate, for planning and decision-making
- carrying out regular analyses of spending and reporting on significant variances
- ensuring that energy costs are properly budgeted, based on realistic cost drivers
- identifying and evaluating potential improvements in control, for example through cost-benefit analyses of extended metering systems
- participating in any energy teams or task forces which are formed (Bennett and James, 1997).

Eco-balancing

An eco-balance can be defined as an environmental balance sheet which quantifies the complete inputs and outputs of substances and energy of an organisation or site. Although there is no difference in principle between an eco-balance and the 'mass balance'

technique which is widely used by engineers, in practice eco-balances are more comprehensive and detailed. Most of the work which has been carried out on this topic has been done in Germany, and the best known practical example is that of the German textile company, Kunert (1994). However, the Fondazione ENI Enrico Mattei (FEEM) has also developed a methodology which has been applied to a number of Italian companies (see the Agip and Italia Petroli case studies). The SGS-Thomson case also describes a similar initiative, which is to develop a comprehensive Environmental Data Bank prior to allocating key environmental effects, such as energy and water consumption, to specific production lines or divisions.

The waste minimisation exercises conducted in the UK and USA can also be considered as a form of eco-balancing, but are generally less systematic in approach and content.

The aim of eco-balancing is to broaden the framework within which particular environmental problems are considered in order to develop more effective solutions or to reveal hidden opportunities (James *et al.*, 1997). It is also a useful means of generating data for environmental performance indicators and environmental reports. However, the generally ad hoc nature of eco-balances and their focus on meeting the specific objectives of environmental management can mean that their potential for eco-management accounting is not fully exploited.

To do this requires data from a wide range of sources within the organisation and a corresponding need for cross-functional collaboration to achieve it. This collaboration can be valuable not only for the data it gathers but also for the connections it forms between formerly separate departments and individuals. These connections can sometimes create new understanding and provide a basis for future collaboration on other environmental activities. Hence, it provides a potential means of helping to integrate management accounting into environmental management.

Risks assessment/rating

A proper management of environmental risk requires:

- the identification of causative factors
- the assessment of the probability that a given (adverse) event may occur
- the evaluation of eventual damage.

The use of historical data helps to identify possible causative factors and to assess probabilities, but does not provide information of the same quality and relevance for the evaluation of possible environment- related damage. This is particularly difficult to assess since it is largely dependent on unpredictable variables such as the sensitivities of local communities and the values which they place on local flora and fauna and amenities. Past experience may be a guide, but little more.

The Italiana Petroli Ecomac case provides a useful insight into the sophisticated methodology used by a downstream oil company to assess risk in its distribution management

network and to link this with accounting. In that case a system for ranking priorities was set up in order to identify priorities and the most appropriate strategies to prevent and manage the risks of oil spills.

Environmental risk assessment and rating can be also performed by external bodies like investors, rating agencies, bank and insurance companies. The growing interest in the possible financial implications arising from environment-related risks has stimulated these bodies to review companies' ability to manage risks before investing, insuring or lending money (Bennett and James, 1998b; Business and the Environment, 1998; Lascelles, 1993).

1.10 Other management

1.10.1 Objectives

Eco-management accounting has implications for, and requires data from, many other functions and operational areas. Its objectives in this respect can be summarised as:

- identifying and making better use of relevant data (e.g. in job process records) within non-accounting and non-environmental management systems
- introducing eco-management considerations into relevant processes and activities, e.g. product development
- building other management areas and representatives into initiatives to develop the scope and depth of eco-management accounting generally.

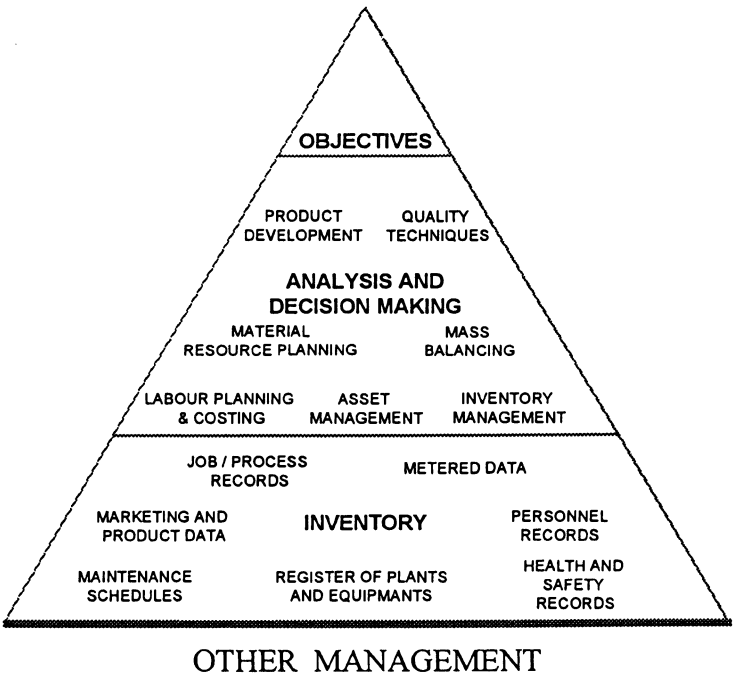
Figure 1.10.1 summarises the main data sources and techniques which are of relevance to eco-management accounting.

1.10.2 Data Inventory

The main operational data sources of relevance to eco-management accounting are:

- job and process records
- personnel records
- marketing and product data
- maintenance schedules and registers of plant and equipment
- health and safety records.

Figure 1.10.1 Other management



Job and process records

Job and process records are relevant to eco-management accounting since they can contribute to:

- the identification of the causes of environmental impacts
- the identification of potential areas for improvement
- the identification of environment-related costs.

The latter is obviously of particular relevance. In the case of Zeneca, job data was critical in achieving the high savings from waste minimisation. In the case of AGIP, the company wished to undertake a cost-benefit analysis of alternative drilling fluids which, although more expensive to purchase, promised lower waste treatment and disposal costs. The analysis proved to be relatively straightforward because the existing job record system contained detailed records of waste generation and disposal for each individual drilling well.

Job and process records are also essential data for accountants when calculating the costs of processes and/or products, for several possible reasons. Process costs are used

in evaluating alternative methods of production of a given product, and in evaluating the cost-effectiveness of investments in new plant and equipment in order to reduce operating costs such as labour, materials and energy, and/or to increase productivity. Where they can be aligned with individual managers' responsibilities they are an input into performance evaluations, through analyses of the variances between actual and expected performance.

Product costs are needed both as a part of the financial reporting process (to provide values at which unsold inventories of finished and part-finished products at period-ends should be reported in Annual Reports), and also to support a wide range of decisions internally. These can be both short-term (for example, in deciding production volumes and mix for the next operating period) and long-term (in pricing, and decisions on the introduction of new, and the discontinuance of old, products). Conversely, accountants' skills in analysing and comparing large quantities of detailed quantitative data can be drawn on by benchmarking exercises in operational areas.

Personnel records

As with job and process records, staff records can also be valuable for eco-management accounting. They are especially important in calculating total environment-related labour costs, where the time of staff who have part-time environmental responsibilities has to be captured. Finding staff with some mention of environment in their job responsibilities can be a starting point for this.

The incorporation of environmental responsibility into operational activities also requires alteration to job descriptions and performance-related pay schemes.

Clear definitions of individual and team responsibilities are also essential for variance analysis to be effective in performance measurement and control, as part of 'responsibility accounting'. These variance analyses can then inform and support personnel management, in helping to determine how effectively particular individuals and teams have discharged their responsibilities.

Marketing and product data

Environment-related cost can be an important marketing issue. In a number of areas such as washing machines or computers some products might be relatively more expensive to buy than others, but also have proportionately lower energy and other costs. Customers may also be liable for end-of-life disposal costs. Marketing departments can be an important source of data about both these cost issues and also their importance to customers.

Marketing data is important too in considering the revenue dimension of eco-management accounting - that which is potentially relevant includes:

- product durability and ownership (e.g. second-hand sales)
- patterns of product use

- product reliability
- end-of-life routes (e.g. disposal, disassembly, recycling).

Maintenance schedules and registers of plant and equipment

Plant registers and maintenance schedules contain information which is needed to avoid possible non-conformity situations, adverse incidents, and the excessive obsolescence of plant and equipment, and to minimise operating costs and deliver quality products.

Relevant data for eco-management accounting includes:

- technical descriptions of plant and equipment, including its capacity, power, and expected working hours
- historic data, for example any past problems which have been experienced, and their causes
- performance data, such as hours worked, inputs and outputs, and energy consumption
- the expected useful working life and performance trends of plant and equipment.

This data can be used to assess the environmental and financial costs and benefits of making changes, for example, through improvements to existing plant, increasing and changing the current levels of maintenance activity, and by replacements of plant and equipment.

Our research suggests that maintenance is especially important as preventative maintenance programmes can reduce both accidental risks and routine emissions and also allow more efficient use of materials.

Health and safety records

Some organisations integrate their health and safety management with their environmental management function whilst others keep them separate. In either case, health and safety records will contain such useful eco-management accounting data as:

- the number and frequency of incidents
- the severity of incidents (expressed in various forms, for example the number of working hours lost),
- the causes of incidents
- costs incurred to remedy damages.

The similarities between health and safety and environmental management also mean that there is potential to apply some of the techniques of eco-management accounting to health and safety. This has traditionally been regarded in many companies as necessary and worthy but not directly value-adding, and therefore contributing costs but not direct or measurable benefits - similar to the traditional perception of environmental management. However, some companies are looking at good health and safety management as a potential source of direct business benefits which can be measured in financial terms. To be complete, this requires measures of intangible and remote (but nevertheless potentially

substantial) benefits. Baxter is examining how to extend the quantified cost/benefit approach represented in its Environmental Financial Statement, to health and safety also. The benefits from good health and safety are not only the more obvious and direct, such as avoided financial penalties through fines and claims against the company, but also more intangible benefits such as the avoidance of disruptions when key staff are off work, and the increased productivity and morale of a healthy workforce. The results of this can be used to make a business case, on financial grounds, for (for example) spending on physical fitness facilities for staff.

1.10.3 Analysis and Decision-making Techniques

Some key environment-related topics here are:

- quality techniques
- asset management and inventory management
- labour planning and costing
- material resource planning and mass balancing
- product development.

Quality techniques

As suggested in other sections of this text, the implementation of quality management systems and approach can be very beneficial for environmental management activities. There are several reasons, including:

- the general attitude of the organisation which is developed under a quality management system can help staff, suppliers, and customers to comply promptly with the company's environmental management objectives (see the UK Xerox case)
- quality concepts already include some environmental management drivers, such as the aim to minimise the consumption of resources, and internal and external failure costs; co-operation between the organisation and external stakeholders; and participation of all employees in achieving business objectives
- personnel records and procedures contain quality prescriptions that can be easily extended to the environmental area
- quality system certification schemes such as the ISO 9000 series speak the same language as environmental management system standards which were largely developed using the quality systems as models: the ISO 14000 series (and its predecessor which it supplanted, BS 7750) and to some extent the EU's EMAS scheme
- the 'cost-of-non-quality' approach to accounting for quality-related costs can be adapted and extended to include the 'cost-of-non-environment'.

The accounting system is a source of at least some of the data to support both cost-of-non-quality and cost-of-non-environment analyses, though more judgement and creativity is needed to identify the more remote elements such as the costs arising from external failure. However carrying out an analysis which determines that, in total, spending on pre-

vention and appraisal will be more than compensated by savings in internal and external failure costs, is on its own insufficient to ensure that these potential gains are actually realised. To achieve these it is essential that consequent adjustments are made to the budgets and performance targets of those who are in a position to take the necessary actions.

Xerox (UK) provides an example of this, in a slightly different context. A cost analysis over the whole of their logistics chain showed that substantial net savings were available through a fundamental re-design of their packaging. However this affected all stages in the chain, and the effect was to require increased spending in some stages. Adjustments to the budgets of the managers responsible for these stages, to allow increased spending, was necessary in order to enable and motivate them to support the new system. On the other hand other managers' spending budgets were adjusted downwards. Since the change as a whole produced net overall savings, the upward adjustments in some stages were more than compensated by greater savings elsewhere.

Asset and inventory management

Asset management focuses mainly on plant and equipment, buildings and real estate, intangible assets and equity investments.

The management of these activities can influence overall environmental performance, especially in manufacturing companies. Here, corporate liabilities and impairments of asset values which may arise if environmental issues are mis-managed can represent a major threat to a business's economic performance and in some cases to its continued existence. Potential liabilities to clean-up contaminated land stand at several hundred billion dollars in the USA (Schoemaker and Shoemaker, 1995). Although the figures are lower in Europe - both because clean-up requirements are generally less onerous and also because the continent's regime avoids the high legal costs of the US system - they can nonetheless be substantial.

The case of Italiana Petroli, a large downstream oil company operating more than 2000 petrol stations, shows that environmental management can be successfully integrated with the general management of assets in order to avoid future environment-related liabilities. In that case, if inventories and other assets were mis-managed the consequence could be oil spills, with large financial implications for the company.

Asset management in other sectors is also affected by environmental issues, for example in the manufacture of refrigerators and air-conditioning devices which have faced the problem of reliance on CFC-dependent (and therefore now obsolete) technology. In an indirect way, this applies also to investment banks who now assess possible environmental liabilities before advancing loans to business customers.

Accountants depend on full and reliable information from general managers on assets and inventories in preparing published and internal financial reports, in order to assess the

appropriate levels of provisions, depreciation charges, and possibly liabilities and contingent liabilities. Conversely, cost information from the accounting function can help general managers to identify high-cost areas and focus their efforts there.

Labour planning and costing

Labour costs are a substantial proportion of total costs for most organisations, including even many which would consider themselves highly automated, and is usually still one of the main elements in standard process and product costs.

Labour costs of environmental staff can be significant, especially when a proportion of the salaries and related costs of people spending part of their time on environmental matters is taken into account. They formed the largest element of direct environmental costs in several of the Dutch case studies, for example.

The labour costs involved in processing materials to the point at which they become waste can also become significant.

Material resource planning and mass balancing

Materials are a major cost item for most businesses, including service industries - although they will not need to purchase raw materials to go directly into final products, they may still require substantial quantities of consumables such as stationery. Reductions in materials wastes and purchases can produce both environmental and economic benefits, but require the support of general managers who are familiar with how materials are handled and used in operations in order first to identify the opportunities and then to achieve them.

Zeneca provides an example of this, where a cost analysis of wastes at each of several stages in a multi-synthesis manufacturing operation demonstrated that, in total, avoidable costs of waste were substantially higher than had previously been realised. This analysis, and the actions needed to achieve the savings which it showed were possible, depended on the technical expertise and in-depth knowledge of operations of the chemists and chemical engineers who designed and managed the company's operations. The Cartiera Favini case also shows that detailed information on mass flows in the production of paper was crucial in designing innovative paper lines and in finding creative end-of-pipe solutions.

In many cases opportunities for better materials utilisation will be identified by normal business processes. However, experience suggests that this is not always so and that environmentally-driven waste minimisation initiatives can produce results.

A further finding from our study was a lack of integration of environmental management with the enterprise resource planning software systems such as those of SAP or Baan which are becoming increasingly prevalent in large companies. Although several manu-

facturers offer environmental modules none were being utilised in the companies we studied.

Product development

When product development processes take environment into account they typically do so through some form of more or less complex life-cycle assessment and use of various decision tools which screen for particularly serious impacts and/or score performance with regard to different impacts. IBM, for example, has a sophisticated system of this kind which it applies to all products.

However, this data is seldom translated into cost terms even though - as the XYZ case showed - they can be substantial. Hence, there is scope for accountants, environmental managers and others to:

- identify, control and make provision for the costs associated with current products
- ensure that potential environment-related costs and liabilities are considered and, wherever possible, taken into account in new product development decisions, e.g. by making product disassembly easier so that end-of-life recycling becomes more cost-effective
- ensure that possible environment-related changes in input prices are recognised and taken into account in product decision-making.

This can be achieved by incorporating a formal environmental component (which considers costs as well as physical impacts) into go/no-go decisions about product development.

These actions can be taken not only within individual companies but also in partnership with suppliers and/or customers. In the Xerox UK case, for example, packaging costs were reduced as a result of sharing accounting and operational data between various participants in the chain so that the overall costs could be understood, and opportunities for cost reduction could be identified. The XYZ case also demonstrated how bringing the know-how of recyclers into the design process could help to create products with lower end-of-life costs than would otherwise have been the case.

1.11 Organisational structure, culture and processes

So far, the discussion has focused on issues and changes within the three domains of accounting, environmental and energy management and other management. However, these are not self-contained. All are influenced by general features of the organisation. Tichy (1983) has identified three important organisational variables, all of which are relevant to eco-management accounting:

- structure
- culture
- process.

As the lines in figure 1.7.1 indicate, these variables play an important role in integrating and harmonising activities within the individual domains and indeed in shaping the specific actions which are taken. Companies with a short-term and heavily finance-dominated corporate culture, for example, are much less likely to consider issues of sustainable business than those with a longer-term perspective.

Structure

The most fundamental aspect of structure is the degree of decentralisation within the organisation. In highly decentralised organisations the fundamental decision-making centres will be business units and large sites may also enjoy considerable autonomy. We found several examples in our cases and survey where this autonomy translates into the operation of different accounting systems so that there are problems of data compatibility between business units.

Decentralisation does give scope for introducing local initiatives on a small-scale basis, e.g. in response to particular environmental circumstances. They can then be extended across the whole organisation if successful. However, it can also make it difficult to take any action which requires co-operation between different business units. Often too, these units have a less strategic perspective than the corporate centre and may therefore be less persuaded by arguments about long-term pressures such as the likely future internalisation of external costs. On the other hand, centralisation can tend to encourage a 'convoy' approach to environmental management and a stifling of local initiative. Several corporate environmental managers in our survey noted the importance of these factors and the practical difficulties which they created for both environmental management and eco-management accounting.

These issues are particularly pronounced in the case of local subsidiaries of transnational enterprises, which range from very limited to almost complete autonomy. USA ownership in particular can be an important driver of eco-management accounting, as corporate initiatives developed in the high environmental cost context of America are made either mandatory for, or available to, local subsidiaries. This was the case with Baxter's development of a site environmental statement for its Castlebar plant, for example (see case). The global perspective and management of many transnational organisations can also create another use of eco-management accounting, which is analysing the costs and benefits of national regulations and comparing these with those of other countries and/or an organisationally preferred alternative.

Another aspect of structure is the extent to which the organisation is based on strong and independent functional departments. Generally speaking, German companies are more likely to have such structures whereas American and British companies have been using a variety of mechanisms to break them down. This has major implications for culture and processes (see below) and also determines the role and objectives of the accounting and environmental management function (Becksmann, 1996; James *et al.*, 1997).

The Zeneca case provides a particularly interesting example of the influence of structure on eco-management accounting. The waste minimisation initiative at the Huddersfield site was initially driven by the environmental department of one of the company's autonomous business units and then taken up by site staff. However, the case identifies one factor in the success of the initiative as being the presence on the site of a corporate service function, Zeneca Manufacturing's Process Development department.

Culture

Many factors influence the culture of a company. One of the most fundamental is its purpose, as manifested in the objectives and behaviour of senior managers. One simple distinction is between 'bottom-line' and 'stakeholder' organisations. 'Bottom-line' organisations have a primary focus on financial issues, whereas stakeholder organisations see financial performance as just one factor in meeting the needs of a variety of stakeholders, which includes employees and communities as well as shareholders. The two approaches have broadly correlated with national differences, with the former being more prevalent in the strong-capital-market contexts of the Anglo-Saxon economies of the UK and USA, and the latter being more prevalent in Germany (James *et al.*, 1997) as well as other continental European countries and Japan. The differences have importance consequences for accountants and financial managers. They are usually central figures in the decision-making of Anglo-Saxon companies (to the point where this is a frequent background for those who become company chief executives and chairmen) but are generally less prominent in European and Japanese enterprises.

These cultural differences are reflected in the different forms that business-level eco-management accounting has taken in the two areas. In USA and UK companies (and, usually, their overseas subsidiaries) the emphasis has been on 'bottom line' initiatives such as waste minimisation which offer immediate pay-offs. Although accountants as such have not been prominent in these, their concerns - such as the use of the pay-back method, etc. - have been. In Germany by contrast there has been more emphasis on eco-balancing, an activity largely conducted by engineers and scientists and focused as much on holistic understanding and long-term benefits as on short-term returns.

This point was also confirmed by a USA case study of the electroplating industry which found that organisations with strongly bottom-line cultures tended to be more supportive of eco-management accounting (Environmental Protection Agency, 1997). This is a consequence both of the high cultural value placed on accounting activities and its potential for immediate reductions in cost.

However, whilst still valid, the picture is now becoming more complex. Economic difficulties are leading many European and Japanese companies to put greater weight on bottom line considerations. Conversely, there have always been some stakeholder-focused companies in the UK and USA and there is currently much debate about their merits and the British Labour Government is officially seeking to support their development.

Organisational processes

Effective and enduring cross-functional processes are vital for successful eco-management accounting for three reasons:

- many of the practical actions which can be taken require collaboration and concerted action by different functions, such as accounting and environmental management
- some important opportunities - such as the ability to capture new kinds of data or to re-classify existing data categories as a result of the introduction of activity-based costing - arise only at irregular intervals. If good relationships and understanding between functions are not already in existence it can be difficult for such opportunities to be identified and/or implemented
- an important underpinning of eco-management accounting is financial literacy and operational understanding amongst environmental managers, and environmental awareness amongst accounting and operational staff. One important means of achieving this is regular contact and good personal relationships between individuals within these different functional areas.

Our research found only two companies which had generated new processes which brought together accounting and environmental staff to meet environmental objectives. One of these was Akzo, which has created an 'environmental book-keeper' to co-ordinate accounting, environmental management and operational data. The other was Xerox UK, whose quality improvement team which brought together accounting, environmental, logistics, packaging and other staff to focus on opportunities for packaging reduction. However, even in this case the principal original objective was cost reduction rather than environmental improvement.

Several of the case studies and survey interviews also demonstrated the sub-optimal situations which can arise from the absence of such processes. At XYZ, for example, the workshop organised as part of the case study was the first time that the key players in assembling and approving the business case for product development had been exposed to environmental issues, or indeed had met the product development team in its entirety. As a result, all attendees had a much better understanding of the role of environmental issues in determining the long-term feasibility and profitability of the project.

This finding of an absence of spontaneously arising processes to bring together the three domains of eco-management accounting - and particularly those of financial and management accounting - corresponds to other research findings and anecdotal evidence. Hence, there appears to be a need for specific process initiatives, either on an intermittent basis to meet specific objectives or as a starting point for more regular interactions which ultimately become assimilated into everyday business activities. In some cases this will involve the development and/or formalisation of existing processes, but in others new initiatives will be needed. Some examples of these include:

- eco-balancing and similar exercises (see section 1.9.3)
- creation of environmental financial statements (see Baxter case)

- creation of 'green teams' such as that developed by AT&T (EPA, 1995)
- development of an environmental management system with a strong eco-management accounting emphasis (see section 1.9.3).

1.12 Sustainable business

Sustainable development is notoriously difficult to define, but has three core elements:

- *economic development* is necessary and will continue but will be based on sustainable production and consumption - which in turn requires new kinds of goods and services
- a considerable reduction in the *environmental impacts* of human activity
- *social justice*, in a world which has less disparity between countries and social groups and which provides the basic needs of adequate food, health care, clean water, sanitation and shelter for all its citizens.

Elkington (1997) has characterised the business implications of this as the 'triple bottom line' - economic, environmental and equity. All of these can be difficult to encompass at the day-to-day business level, and require a more strategic perspective.

An economically sustainable business can be defined as one which achieves its immediate commercial objectives. Doing this requires good accountancy, environmental management and general management. However, it also requires some degree of strategic analysis and action in order to anticipate future threats and opportunities and take appropriate action to avoid or grasp them. Eco-management accounting can play an important role in developing such analysis and building rationales for action - for example, by demonstrating the link between environmental and social issues and long-term shareholder value, or by highlighting the potential economic, environmental and social benefits of close co-operations with suppliers, customers and other participants within product chains.

The social justice dimension of sustainable development poses hard questions about the purposes of companies and the acceptability of many current business activities and views. This project has not considered these issues, on the pragmatic grounds that dealing with the environmental aspects of sustainable business is a major area in its own right. However, we recognise their importance and hope that our own results will be of value to those seeking to develop an integrated approach to the topic (for example, Elkington, 1997; Zadek *et al.*, 1997).

Focusing on the environmental dimensions of sustainable business, it can be argued that one of the main objectives of eco-management accounting should be what has been termed 'environmental value analysis' - the relationship between an organisation's economic value added and its environmental impacts (Bennett and James, 1997). This can be evaluated in two ways:

- eco-efficiency measures
- economic valuation of environmental impacts.

Eco-efficiency measures relate environmental impacts to an economic parameter. The latter measure can take a variety of forms - for example, turnover or profits - but as value added is a more direct measure of the net economic contribution made by a company, it is widely considered to be the most appropriate. Calculations can then be made of value added per tonne of emission or unit of environmental impact or, alternatively, tonnes emitted or units of environmental impact per £ of value added. These give a crude measure of how efficiently organisations or, in aggregate, industries are using environmental resources.

However, knowing that an organisation is using resources efficiently says little about whether their use is sustainable. Sustainability implies limited 'eco-capacity', i.e. a finite availability of physical resources such as fossil fuels and biological materials and of environmental 'sinks' such as the atmosphere. The costs of exceeding this eco-capacity can, in principle, be calculated and then disaggregated to the level of the individual firm via taxes - for example, a carbon tax - or other means. The relationship between these 'costs of unsustainability' and value added can therefore be a crude measure of an enterprise's sustainability.

Of course, in a world where all such costs are internalised through taxes and other measures then sustainable value added would be the equivalent of economic value added, but this is far from being the case at present. Hence, approximations to sustainable value added can be produced by making estimates of damage costs. In the case of environmental damage costs, figures are available for many impacts although there is limited consensus about the best basis of calculation or their accuracy. In the case of social damage costs, few figures are available and this situation seems unlikely to change for the foreseeable future.

Only one organisation has so far made even a crude attempt to calculate its sustainable value added. This is the Dutch computer services company BSO Origin, who in its 1992 environmental report calculated its main environmental impacts and then converted these into financial amounts to represent the imputed costs of those impacts. The data for this was based on calculations of long-term costs of control in the Dutch National Environmental Protection Plan. This gives a net cost of each environmental impact individually, and of all their environmental impacts in aggregate, which can be compared with the value added as calculated through their conventional business accounting processes. Although the approach can be criticised on a number of grounds it nonetheless marks an interesting first attempt to deal with a topic which is likely to be of growing importance.

1.13 Conclusions and implications

1.13.1 Conclusions

Our study has shown that:

- There are significant differences in eco-management accounting between individual countries and sectors. The national differences - which relate to areas such as interest in eco-balancing or linking to shareholder value (with the former more prevalent in Germany and the latter in the UK) - were anticipated. More surprising was the variation within sectors, which refuted an initial project hypotheses that similar business activities would tend to generate similar accounting approaches. However, there were also many commonalities, which we discuss below.
- Although the field is in its infancy, there are already a number of European initiatives in the field of eco-management accounting and many accountants and financial managers expect its importance to increase in future.
- Environmental costs can be considerable. The most noteworthy examples from our cases were those of Zeneca and Baxter. The former estimates that in recent years it has saved several million pounds through its costs-of-waste initiative. The Baxter site report which was prepared as part of this project also showed that environmental activities had generated benefits of over one million Irish pounds.
- However, arguments that 'bottom-line' considerations will be major drivers of environmental improvement in European business can sometimes be exaggerated. In general, the fact that Europe does not have a USA-style liability and environmental penalty regime means that direct environmental cost drivers are not as intense as over the Atlantic. Our Dutch cases, for example, found that - in a country with one of the most stringent environmental regimes in Europe - they accounted for only around 2% of turnover of the chemical companies researched.
- On the other hand, European-based companies tend to face higher resource costs than American ones so that their 'costs of inefficiency' - the costs of buying and processing resources which ultimately become waste - will often exceed direct environmental costs. To some degree, these can be tackled without any environmental initiative through normal efficiency improvement measures. However, their continuing existence demonstrates that more can be done in practice.
- Internal environmental costs are often not identified and/or allocated by conventional management accounting practices. Hence, there are opportunities for a number of companies with significant environmental costs to generate both environmental and financial benefits through their improved identification and allocation.

- The linking of management accounting to environmental management will enhance the financial superiority of pollution-prevention measures relative to end-of-pipe measures to some degree. However, this requires allocation as well as identification of costs and will be impeded if decision-making depends solely upon evaluations using the pay-back method, or on discounted cash flow models which use excessively high discount rates.
- Where companies are taking initiatives in eco-management accounting, the most common area is the incorporation of environment into capital investment appraisal processes. However, this is often done in a superficial manner. Other areas are less well developed at present .
- There is evidence that life-cycle costing initiatives, which attempt to cross organisational boundaries and to consider costs on a product chain basis, can be fruitful in identifying opportunities for both cost reduction and environmental improvement.
- There are currently poor linkages between environmental managers and management accountants - those between environmental managers and other managers are often more important to eco-management accounting in practice. One of the major surprises from our case studies was the importance of operational data such as job and process records in gaining an accurate understanding of environment-related costs and benefits.
- This is a major problem because the organisational process dimensions of eco-management accounting can be as important as the content, in particular by developing, in advance of any specific initiatives, awareness in and relationships between departments and individuals.
- The financial benefits of introducing eco-management accounting do not usually justify major changes and are therefore better achieved by integrating environment into existing change activities such as activity-based costing.
- For most companies, eco-management accounting will be an intermittent process in which periods of low-level, low-profile, activity are punctuated by bursts of considerable attention and innovation. These are often triggered by changes such as the introduction of new internal accounting systems.
- One reason for this is doubts about the credibility of long-term projections of environmental cost. Although many companies expect these to increase, few attempt to quantify them - for example, by considering current levels of externalities and how these might be internalised in future - in a way which can be used in decision-making models. More work is therefore necessary both in generating additional data, and in studying cost-effective and feasible ways of signalling such trends to business.
- Externalities data is contentious but can be useful in some business contexts. An example is constructing scenarios for long-term investment decisions. One of our case

studies (XYZ Company) shows how calculation of externalities can, at the very least, be a useful marketing tool for new products and services which reduce transport requirements. This might be further increased if more data were available - there is currently a lack with regard to key environmental parameters, such as the use of materials, or many forms of toxic emission.

- There are problems of data reliability. This is partially related to a lack of standardisation of terms and techniques which is hampering development. Although eco-management accounting is subject to the general management accounting maxim of 'different costs for different purposes', standardisation is important for many reasons, such as benchmarking and national statistical purposes.

Although eco-management accounting is primarily focused on supporting internal management, the high degree of external attention to corporate environmental performance also means that external stakeholders have an interest in the topic. This is often confined to wanting reassurance that a company is addressing the issues rather than seeking specific financial information (Bennett and James, 1998b). This appears to be partly because they place a higher priority on non-financial rather than on financial information, but also because they have little respect for figures on environmental expenditure which are based on non-standard definitions. There is a need for more work in this area to examine what eco-management accounting can provide that would be of value to external stakeholders.

One final - and reassuring - conclusion is that eco-management accounting is complementary to, rather than in opposition to, other trends in business and accounting. Indeed, as Bennett and James (1998c) have observed, in many ways, environment-related management accounting is merely the application of many of the ideas of advanced management accounting to a particular area. For example:

- it forms one element of the 'balanced scorecard' approach advocated by Kaplan and Norton (1996)
- it can be seen as a specific application of activity-based costing (ABC) which focuses on environment as a key cost driver
- its emphasis on end-of-life and other downstream and upstream costs from the organisation itself relates to broader debates on the topic of product-life costing
- the environmental critique, that conventional investment appraisal has difficulties in dealing with uncertainty and long-term strategic benefits, links into more general discussions on these topics
- its emphasis on future threats and opportunities reflects the argument that management accounting in general must become more strategic and less focused on short-term controlling and reporting (Johnson and Kaplan, 1987).

This - and the apparent inevitability of rising environmental costs over the medium-long term - is the reason why the topic is destined to become more important in the future.

1.13.2 Implications

Our conclusions have significant implications for business in general, professions and functions such as accountancy and environmental management and policy-makers, which we now explore.

Business

Our study suggests that many companies can and should - for both business and environmental reasons - do more in the area of eco-management accounting, and that the pressures for them to do so will increase. On the other hand, the extent of the financial drivers can easily be exaggerated and the costs of taking action - particularly those involving changes to accounting systems - can easily be under-estimated. Hence, any actions need to be realistic and cost-effective and will often involve incremental changes to existing activities rather than completely new ones.

The importance of developing processes which link environmental management with management accounting suggests that the best starting point for eco-management is some form of cross-functional team bringing together both these functions and others. This also ensures that any initiatives are more likely to meet the company's strategic needs than if introduced by a single function. A related measure is to ensure that environmental managers are involved in any significant changes to accounting and financial management activities.

In general, however, it is likely that most companies will concentrate their attention and activities on five areas:

- paying greater attention to environmental issues during project appraisal
- improving the identification and management of significant environmental costs
- exploring opportunities for waste minimisation initiatives
- considering potential environmental costs during product development processes
- making greater use of accounting data and expertise to assist environmental performance measurement.

Companies which have substantial environmental costs also have an opportunity to develop cross-functional, strategic, approaches spanning all of these areas and others.

The uncertainty of long-term cost data also means that flexible methods of assessing long-term risks, such as scenario building, may be more appropriate than techniques which require high degrees of precision.

The educational materials which have been produced as part of the project provide further information on these points.

Professions and functions

It is clear that eco-management accounting requires a greater degree of awareness and action amongst individual accountants and accounting departments. It is unlikely that this will happen without continued and enhanced action by accounting bodies. This is necessary in a broad sense to encourage and legitimate their involvement of accountants in what can seem an esoteric and peripheral topic, and more specifically to help to raise environmental awareness in the profession and to overcome some of the informational barriers to their involvement which currently exist. These encompass both narrow issues such as definitions of data, and broader concerns such as the current dearth of good case studies and teaching materials about the use of financial and other accounting-relevant indicators.

A number of initiatives have already been taken in this regard - including guidance on the role that management accountants can play in environmental management (CIMA, 1997) - but more needs to be done. In particular, accounting bodies have an opportunity to support the development of relevant environmental training and education, including through inclusion in professional accounting syllabuses. They could also help to develop 'best practice' examples of the ways in which accountants and environmental managers can work together, and tools such as standardised definitions of environmental costs and benefits or model protocols for areas such as consideration of environment in capital expenditure decisions or life cycle costing.

Similar points apply to the role of environmental professional bodies in developing the financial awareness of environmental managers.

Government

One immediate implication for policy-makers and regulators is the difficulties created by the disparity between definitions of environmental costs for national statistical purposes and those being developed at the organisational level. As we have noted, the former has little direct relationship with either the economic impact of environmental issues on a business or the extent of its commitment to improving environmental performance.

Beyond this, eco-management accounting can potentially assist policy-makers in a number of ways, including:

- developing internal business pressures for environmental improvement, thereby helping to achieve environmental policy goals
- increasing the effectiveness of market-based environmental policy initiatives such as environmental taxes
- providing data on the cost-effectiveness of alternative policy options.

However, policy makers should not regard companies as a 'black box' in which price signals - in the form of higher costs for environmental impacts - are automatically recognised within accounting systems and decision-making processes and then translated into action.

As we have shown, there are four hurdles to overcome in translating signals about costs and benefits into environmental action:

- identification of the costs and benefits
- allocation of the costs and benefits to relevant decision-making activities, e.g. budgets or investment appraisal
- assessment of any actions, compared against other environmental or non-environmental actions
- prioritisation and implementation of the actions.

The main responsibility for dealing with these hurdles lies with business. However, there is a case for educational material or other initiatives being undertaken for accountants and other experts when new market-based policies are introduced.

In the longer run, eco-management accounting is likely to be given high priority only if environmental costs are perceived to be high and, perhaps more important, to be on a rising trend so that permanent rather than ad hoc responses are appropriate. Unfortunately, policy signals do not always send out such messages. At the time of our study, for example, any arguments in the UK about possible rising costs of resources (and therefore of wastes) were undermined by the reduction of VAT on energy for non-business consumers. The significance of such lack of consistency in the setting of public policy is an important question for future research about the best means of signalling future cost trends. A series of large but intermittent increases in costs can be more attention-grabbing at a point in time, but could also be perceived by many businesses and consumers as merely a 'one-off' change which does not require fundamental change. A small, but continuous, rise in costs over time is less attention-grabbing but may be more persuasive that change will continue and that a longer-term response is appropriate.

2 Environmental management and management accounting: a survey among 84 European companies

Jan Jaap Bouma
Teun Wolters

2.1 Introduction

2.1.1 Overview

Environmental management involves management decisions which rely on or at least benefit from management accounting. Management accounting provides management with financial information with a view to fulfilling organisational objectives by planning, evaluating and controlling the organisation's activities and assuring appropriate use of, and accountability for, its resources.

The Ecomac project explored the empirical relationship between environmental management and management accounting through a survey of 84 companies in Germany, Italy, the Netherlands and the UK. This chapter presents the results of this survey. It is important to note that the primary goal of the survey was to explore what management accounting practices can be observed in different kinds of European companies. The sample does not allow representative averages. Comparative conclusions should be drawn with caution.

Section 2.2 describes the conceptual background and problem area of the survey. Section 2.3 explains the objectives, how they have been addressed and which procedures were followed in conducting the survey. The section presents a number of hypotheses that were put to the test and tells how the companies involved were approached. Sections 2.3.1 and 2.3.2 discuss a number of general results. To provide an overall picture of the extent to which management accounting has been used for the purpose of environmental management, two indexes are introduced.

Section 2.4 gives an overview of the results for the entire group of companies. It discusses the various management accounting functions and how important they are to environmental management. Section 2.5 gives a look into different sectors. Section 2.6 explores the effect of company size on the relationships between environmental management and management accounting. This chapter is finished by section 2.7 that presents the conclusions of the survey and the recommendations for research.

2.2 Problem area

The financial underpinning of environmental measures increasingly requires an approach which is systematic and pragmatic at the same time. For that purpose, it is necessary to

connect existing management accounting systems with environmental and other management systems (resulting in full-fledged eco-management accounting).

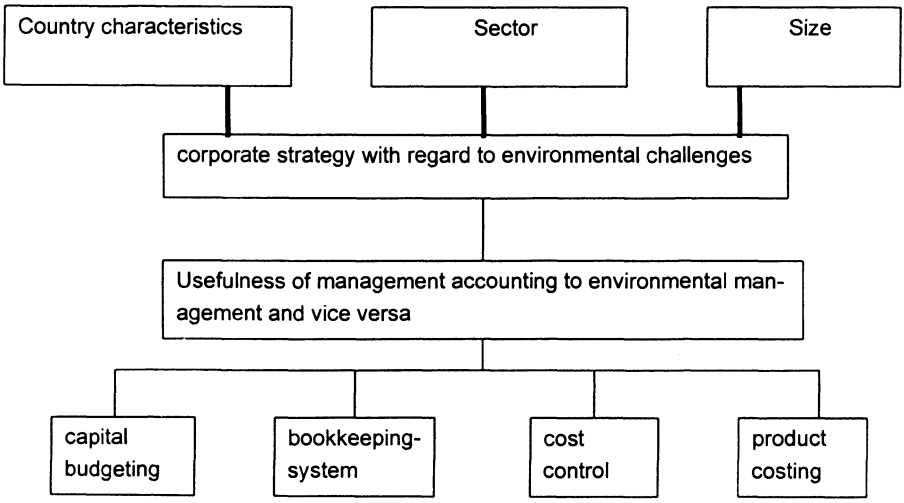
A lack of connection between environmental decision-making and management accounting (laying emphasis on costs and benefits) can create a number of problems which comprise a serious impediment to the integration of environmental aspects into the mainstream of business. These include:

- absence of appropriate concepts;
- insufficient access to relevant data;
- available records are not suitable to address the problems involved;
- a neglect of relevant data which are available in other systems
- a lack of knowledge to deal with and remedy these shortcomings.

The survey examines the practical importance and nature of these problems and the ways in which management accountants and environmental specialists are - or could be - working together to overcome them. It also considers how far environment has already entered into current management accounting practices and what can be expected in this area for the near future.

Figure 2.2.1 presents a framework which indicates the relationships assumed relevant to the design of the questionnaire. These relationships are expected to influence the usefulness of (parts of) management accounting to environmental management and vice versa. It provides a basis for the selection of the facts and factors which the survey is to bring to the surface.

Figure 2.2.1 Relationships that are expected to influence the usefulness of (parts of) management accounting to environmental management and vice versa



It is a well-known fact that contextual variables may influence the functions and structure of management accounting systems and techniques (Johnson and Kaplan, 1987). Contextual variables, such as legislation, may be country-specific. The importance of management accounting to environmental management presumably increases when national environmental legislation leads to substantial investments and operational expenses. Likewise, legislation may require (directly or indirectly) the generation of particular environmental costs statements, and hence the involvement of management accounting.

Besides country, company size and sector are expected to influence the relationship between management accounting and environmental management.

Smaller firms tend to use less formal systems and techniques to provide the management with information. Large firms have more formal structures than smaller firms. This is an important notion because different forms of organisational structure require different types of accounting information (Emmanuel and Otley, 1985).

The sector covers issues like types of technology and environmental challenges. Clearly, such issues determine the nature and relevance of eco-management accounting. Although country, size and sector may be influential, it can be expected that individual differences which cannot be explained by these variables, are considerable. Company history and different managerial tools other than management accounting tools may explain for them.

2.3 The survey

2.3.1 Hypotheses and approach

In general, the survey investigates to what extent management accounting already plays a part in dealing with environmental affairs. It also explores whether there are other problem areas (not recognised beforehand) relevant to the linking of management accounting to environmental management.

The survey also sought to test the four central hypotheses of the Ecomac project, which were that:

- Logical relationships between management accounting and environmental management can be established via the existing production processes and products.
- The linking of management accounting to environmental management will tend to make it more likely that pollution-prevention measures can be demonstrated to be financially superior to end-of-pipe measures.
- Firm-based costs related to emissions to the environment are often not identified by the conventional management accounting practices. As a result, cost savings resulting from environmental measures frequently remain hidden.

- Activity-based costing (ABC) is a promising approach to remedy the 'blackbox' nature of overheads. It can be applied so as to systematically quantify the cost-saving effects of environmental measures.

The survey has been conducted by interviewing a financial controller and an environmental specialist working with each of the selected companies. The environmental specialist could be a full-time or part-time environmental co-ordinator. In smaller companies, the managing director, the production manager or the technical manager were expected to be responsible for a company's environmental affairs, so that they were frequently the ones interviewed then.

Two different parties were interviewed in order to obtain a representative picture of the link between environmental management and management accounting. Those persons who are experts in the fields of management accounting are not necessarily those with adequate knowledge on environmental management and vice versa. We were also interested in whether there were any differences in perceptions between the two categories of expert.

To achieve some comparability between companies, certain preconditions were set:
- Half of the companies were to be SMEs (less than 500 employees, not controlled by another company).
- Each country (the Netherlands, Germany, United Kingdom and Italy) selects two companies in each of the following three sectors (so six altogether): chemicals, electronics and energy.
- To establish a linkage with another EU-funded project, each country selects two sectors out of the following four sectors: textiles, industrial paints (users), electroplating, and printing. An analysis of the combined data is outside the scope of this report, but is intended to be done separately. From each of these two sectors two companies were selected.
- The above two rules represent a minimum amount of companies in a number of sectors. The selection of more companies in the sectors that result from the application of the above two rules was preferred. However, the researchers in each country were free to choose the remaining companies from quite different sectors (such as car services, transport, paper).

The number of companies participating in the survey was 84: from the Netherlands (20 companies), Germany (23 companies), Italy (21 companies) and the United Kingdom (20 companies).

The questionnaire contained 46 questions (see Bouma and Wolters, 1998). The questions were divided into three categories or blocks:
- Nature of the firm
- Environmental Management
- Management Accounting (parts A and B).

The block 'Nature of the firm' served to describe the company according to size, organisational structure, products, mission and strategy.

The second block of questions ('Environmental Management') was mainly directed towards the environmental specialist. He or she was first requested to mention the company's main environmental challenges and to state whether measures to meet those challenges had been taken and management accounting was used to underpin or control those measures. The measures already taken were characterised by means of a technology matrix (discerning phases in the life cycle and a break-down into prevention, re-use/recycling, end-of-pipe).

The third block of questions ('Management Accounting') was divided into part A and part B. While part A dealt with management systems generally and therefore involved both the environmental specialist and the controller, part B primarily addressed the controller as a specialist in accounting issues, such as cost allocation methods, selection indicators and hurdle rates.

In part A, the environmental specialist and the controller were asked to assess the importance of different management accounting activities both now (only environmental specialist) and in the future (both). There were also questions concerning the use of 'activity-based costing' as a tool to generate accurate environmental information. The interviewees were asked whether there is a need for more environmental cost information in their firm, and what measures they had in mind to tackle that need. Both environmental specialist and controller were asked to indicate whether they personally believe that more complete information on environmental costs would increase the chances of pollution-prevention measures. There were also questions as to whether a company looks into down-stream environmental costs (such as product disposal) and externalities caused by its own activities and about external reporting (environmental expenditure, costs and liabilities).

Most questions in part B (for accountants and financial specialists) were taken from the second part of a questionnaire used in an American survey on a similar subject (EPA, 1995a). It asked how decisions were prepared: level of decision-making (corporate, divisional, plant), structure of the budget (budget pools) and involvement of environmental departments in investment appraisal.

The role of overheads in processing environmental cost figures was also examined. For a list of environmental costs categories, it was asked whether they are allocated to overheads or directly to products and processes. It had to be indicated on what basis overhead costs are assigned to processes or products.

The last ten questions of part B dealt with the use of financial indicators and the related hurdle rates for the financial analysis of investment projects. Differences between the assessment of environmental investments and other investments were asked for.

The completed questionnaires were inputs to a database (using D-base III-plus) which was created to structure and analyse the available data.

2.3.2 The importance of Eco-management accounting

The management of the companies involved in the survey use a variety of management systems. 56 percent already had an environmental management system in operation, and a further 24 percent were implementing one. 94 percent of the companies reported the use or implementation of management accounting systems. 43 percent of the companies thought that their present management accounting systems are of considerable importance or crucial to environmental management. The importance of management accounting for environmental management was expected to increase: 74 percent of the companies considered management accounting in the future of considerable or crucial importance to environmental management.

Although management accounting can be of great importance to environmental management, this does not mean that management accounting is fully adapted to the environmental challenges. The interviews provide insights into the impediments to full-fledged eco-management accounting. The following impediments were mentioned:

- The management accounting system cannot generate the information needed by environmental management (for example, because the environmental costs are hidden in general cost categories such as machine costs).
- The management accounting system cannot be allowed to be linked with other management systems, since - for example - the quality of information generated by an environmental management system cannot always be assured to be of a sufficient standard to be acceptable as input to the accounting system.
- The costs of adapting the available accounting systems were perceived to be too high.

58 percent of the firms reported that the environmental department has a role to play in selecting investment projects (capital budgeting). When financial hurdle rates do not apply to environmental project proposals, the environmental department may have to justify them by means of other financial and non-financial criteria (e.g. compliance, future cost savings).

A trend towards integrating environmental considerations into a firm's core business is also manifest in the environmental challenges which firms said they were facing. The survey indicates that prevention and reuse/recycling have acquired a prominent place.

On the level of environmental policy, 53 percent of the companies have integrated environmental concerns into their overall business objectives. Table 2.3.1 presents the survey results concerning general mission and strategy. A majority of the firms have formal environmental policy goals (74%). It is striking that 9 percent of the companies have formal goals which refer to environment only. In these cases general business goals were not documented.

Table 2.3.1 The extent of integration of environmental objectives in formal company policy documents

Level of integration	Percentages
Firms that have formal environmental policy goals integrated into the business-economic policy goals	53
Firms that have formal environmental policy goals separated from the business-economic policy goals	13
Firms that only have formal business-economic policy goals	26
Firms that only have formal environmental policy goals	9

Management accounting systems and techniques may have different functions in providing environment-related financial information. They may serve to:

1. control costs,
2. decide on investments,
3. decide on the design and marketing of products,
4. report on environmental performance to external stakeholders.

In the next chapters the functions of management accounting in environmental management are explored in greater detail. It is expected that these functions depend on a range of variables that may change over time. To have an indication of the overall environmental importance of management accounting in achieving environmental objectives, indexes can be calculated (see Bouma and Wolters, 1998). These indexes show that management accounting already is important to environmental management but has not (yet) fully developed. However, it should be kept in mind that the index involves all possible management accounting activities, which has a moderating effect on the overall average. Certain elements of management accounting, for instance capital budgeting or cost pricing, may play a significant role in environmental matters while other management accounting activities may not. Moreover, one should realise that the sample contains quite a number of (relatively) small companies who in general have less management accounting systems in place than do the larger ones.

In the next section the usefulness of management accounting is differentiated according to the different elements of management accounting (capital budgeting, bookkeeping system, etc.).

2.4 Different elements of management accounting

2.4.1 Introduction

Our European survey is indicative of current practices of eco-management accounting, even though it is not representative of the entire industrial sector. As a similar survey had been conducted in the US (EPA, 1995b), a tentative comparison with what is going on in the US was possible. The 'US survey' (as we henceforth refer to it) was based on a sample of 149 firms while our 'EU survey' included 84 firms.

71 percent of the US firms reported that environmental costs are tracked on a company-wide basis. In the EU Survey only 50 percent of the firms reported to do so. In the US Survey 64 percent of the firms track environmental costs at plant level. In the EU Survey this is only done by 18 percent. According to the two studies, at corporate level environmental costs are tracked in 63 percent of the US firms while among the EU firms this percentage is only 30 percent. At divisional level environmental costs are tracked by 44 percent of the US firms while it is done by only 21 percent of the EU firms. These figures suggest that US companies are ahead of European companies in tracking environmental costs. The limited robustness of the figures does not, however, permit firm conclusions on the extent to which the two regions differ in this.

Both in the US and in the EU, the companies included give different values to the elements of management accounting. The EU Survey shows that *capital budgeting* is perceived as useful to environmental management both now (90% of the firms) and in the future (88% of the firms). Presently, the *bookkeeping system* is also regarded as useful by most firms (80% of the firms). In the future the bookkeeping system remains useful to environmental management. *Cost control* (through budget setting and budget control) is presently useful to environmental management and will be so with a slight increase in the future. This is also the case for *product costing*.

Table 2.4.1 provides insight into the importance of several accounting functions to environmental management (in the opinion of the environmental specialist) in the EU firms. That means, it indicates only whether management accounting is of considerable importance or even crucial to environmental management. So, 'some importance' is left out. Table 2.4.1 clearly shows that management accounting, albeit not for all companies, has gained a significant position in the management of environmental affairs.

Table 2.4.1 Importance of different functions of management accounting to environmental management (percentage of firms)

	Considerable now	Considerable in the future	Crucial now	Crucial in the future	Considerable and crucial now	Considerable and crucial in the future
Bookkeeping system	15	25	9	15	24	40
Operational budget setting	22	36	11	17	33	53
Operational budget control	25	42	9	14	34	56
Capital budgeting	24	30	24	31	48	61
Product costing	17	20	9	19	26	39
Performance measurement financial	21	28	12	18	33	46
Performance measurement non-financial	19	21	17	21	36	42

According to the EU Survey (which is the focus of the next paragraphs), it is the corporate level that usually takes the final decisions on the capital budgets.

83 percent of the firms have a single capital budgeting pool for all capital projects, environmental projects or otherwise. The departments most frequently involved in the costing procedures related to environmental projects (both in the EU and the US) are production/operations, environmental affairs and finance/accounting.

The environmental costs mostly considered in the financial assessment of projects are the most tangible and quantifiable ones (for example waste treatment and disposal costs). Less tangible environmental costs such as environmental fines and penalties are seldom considered in the assessment of projects.

With regard to the use of financial indicators in the capital budgeting process, 44 percent of the firms indicate that they perform 'a less detailed/informal screening' of environmental projects prior to a formal financial analysis. When justifying investments, the pay-back period is the main indicator (35% of the firms), with the most common maximum acceptable pay-back period being 3-4 years, representing 30% of all the companies in the survey.

With regard to cost allocation the following results are noted.

- Most environmental cost items are allocated to overheads. However, there is a clear exception for energy costs which are mostly (62%) directly allocated to process/ product.
- 63 percent of the firms that initially assign costs to an overhead account later reallocate these costs to a product or process.
- The most common bases for allocating overhead costs to products/processes are labour hours (33% of the firms) and production volume (24% of the firms).
- Financial/management accounting is the source for environmental cost information only in 19 percent of the cases. The most frequent source is production/operation logs'. This fact reveals a substantial lack of integration between management accounting and environmental management.

In the following section the different functions of management accounting will be discussed in more detail.

2.4.2 Capital budgeting

The study shows that capital budgeting is of great importance to environmental management. Through this process environmental projects have to compete with other investments proposals. Table 2.4.2 indicates what financial indicators are most frequently used to select investment projects. Sometimes these indicators are used in combination with each other.

Table 2.4.2 The use of financial indicators in capital budgeting

Financial indicator	Number of companies that commonly use the indicator
Pay-back Period	29
Return On Investment (ROI)	12
Net Present Value	7
Internal Rate of Return (IRR)	10
Other	25

The survey indicated that in 33 percent of the firms, hurdle rates (thresholds for approval) for environmental projects are lower than those for non-environmental projects. In 67 percent of the firms, the hurdle rates are the same for environmental and non-environmental projects. Of the firms that have environmental policy goals (41% of the firms), 45 percent have hurdle rates for environmental projects.

With regard to the identification of costs and benefits it should be noticed that there are different degrees of detail in calculating the costs and benefits. Sometimes environmental costs are only referred to in a non-monetary way. This does not apply to the bookkeeping system that registers only monetary values.

2.4.3 The bookkeeping system

Irrespective of a company's environmental strategy, the management may be interested in gaining insight into the resources that are allocated to environmental measures. Of the companies that have published environmental policy goals, 49 percent had taken concrete steps to gain more detailed information on environmental costs. 57 percent of the companies that reported a need for more detailed information on environmental costs had taken concrete steps to fulfil that need and 15 percent had planned to do so. Often these steps meant that the bookkeeping system was adapted so as to render additional cost information. Several times, there was mention of efforts to establish consensus about the definition of environmental costs.

For reasons of cost control and price setting, the bookkeeping system often has to be improved so as to provide insight into the environmental costs as part of the cost price of a product. Management accounting techniques can be important to a firm's price setting. It may provide a justification to lower the price of environmentally superior products.

Operational control and price setting can serve the interests of environmental management only if a firm's environmental costs are accurately allocated to products and/or processes. This will be further discussed in the next section.

2.4.4 The allocation of environmental costs

Although a need for accurate environmental costs is frequently recognised, in practice, there may be serious information gaps. Table 2.4.3 indicates how the companies in the survey allocate environmental costs.

Table 2.4.3 The extent to which environmental costs are allocated

	Percentage of firms where initial assignment is	
Cost item	Always or usually to overhead	Always or usually to product/process
On-site air/wastewater/hazardous waste testing/monitoring	57	30
On-site air emission controls	51	31
On-site wastewater pre-treatment/treatment/disposal	48	27
On-site hazardous waste handling (e.g. storage labelling)	46	38
Manifesting for off-site hazardous waste transport	60	25
Manifesting for off-site hazardous waste transport	57	26
Off-site hazardous waste transport	57	29
Off-site wastewater/hazardous waste pre-treatment/treatment	48	26
Energy costs	48	46
Water costs	46	43
Licensing/permitting	63	21
Reporting to government agencies	68	12
Environmental penalties/fines	49	11
Staff training for legal compliance	73	10
Environmental staff labour time	79	5
Legal staff labour time	64	6
Insurance costs	71	13

Only 26 percent of the companies in the survey use activity-based costing (ABC) to provide insight into environmental costs, and only 18% for product costing. Differences between companies

Section 2.2 presented a model (figure 2.2.1) of the structure of the questionnaire.

To describe a firm's behaviour in relation to environmental management and management accounting, the following aspects have been taken into consideration:

1. The general importance of management accounting in meeting the firm's environmental challenges
2. The actual usefulness of the bookkeeping system to environmental management
3. The actual usefulness of budget setting to environmental management
4. The actual usefulness of budgeting control to environmental management
5. The actual usefulness of capital budgeting to environmental management
6. The actual usefulness of product costing to environmental management

7. The actual usefulness of financial-performance measurement to environmental management
8. The use of activity-based costing to produce adequate environmental cost figures
9. The extent to which concrete measures have been taken to provide detailed information on environmental costs
10. The extent to which regular management accounting provides environmental cost data for external reporting
11. The extent to which typical environmental costs are allocated to the products that bring about these costs
12. The extent to which financial indicators are applied to compliance projects
13. The differences between the hurdle rates (i.e thresholds for approval) for environmental projects and other projects.

Differences in the use of management accounting in environmental management are expected to be related to attitudes expressed in questions 10, 15 and 16 of the questionnaire:

1. The belief that changes in a firm's environmental challenges over the coming years will affect the use of management accounting (question 10)
2. The need for more detailed information on environmental costs (question 15)
3. The belief that, in general, more attention to environment within management accounting would reveal that environmental costs are higher than currently apparent and therefore encourage cost-saving pollution prevention (question 16).

The survey explored which firm characteristics influence corporate attitudes towards the role of management accounting in environmental management. Some potential characteristics are:

1. economic sector
2. number of employees
3. turnover
4. environmental organisation
5. environmental objectives
6. technologies that are involved in the environmental measures
7. country.

The data analysis has been divided into two steps. First an univariate statistical analysis was carried out, which was followed by multivariate analysis. By using the HOMALS application (SPSS, 1990) a reduction of the data has been implemented. The indicators of the three different variables - characteristics of the firm, attitudes towards management accounting and the behaviour with respect to the management tools for environmental cost accounting were analysed with HOMALS. This analysis gave rise to interesting dimensions (new variables).

The indicators related to the firm characteristics gave two dimensions:

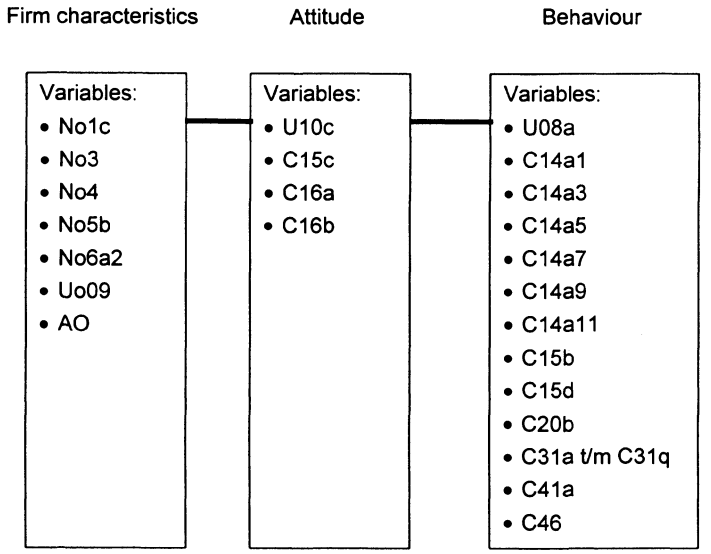
a. dimension 1: small firms in the metal-plating & treatment sector, and the paper and printing sector, who have taken only a few technical environmental measures and have no environmental manager, versus the big firms with environmental departments and many environmental measures;
b. dimension 2: big German firms versus medium-sized firms in other countries.

The indicators related to attitude gave one dimension: firms with negative attitudes towards management accounting, versus those with a positive attitude.

The indicators related to behaviour gave one dimension: firms with extensive allocation of environmental costs to products and processes, versus firms with no or only some allocation of environmental costs to products and processes.

On the basis of the simple 'characteristic - attitude - behaviour' model (see Figure 2.4.1), the HOMALS-dimensions were analysed (Bouma and Wolters, 1998). Only the second dimension of the firm characteristics appeared to be correlated (significance of p=0.02) with the dimension of behaviour. It can, therefore, be concluded that in Germany the environmental costs are significantly more frequently allocated to processes and products than in the Netherlands, Italy and the United Kingdom.

Figure 2.4.1 The expected relationships between a firm's characteristics, attitude and behaviour



By using Homals (version 0.6) the characteristics of a firm, its attitude and behaviour with respect to management accounting are expressed in dimensions (see Bouma and Wolters, 1998). Also, the expected relationships, as expressed in Figure 2.4.1, are explored.

The lack of correlations which the statistical analysis has shown can be partly explained by the relatively small number of companies that were included in the sample. Except for the influence of country characteristics (for example legislation), other variables like sector and size were expected to have a significant influence on the role of management accounting. Besides the limited number of firms, the individual nature of management accounting practices discovered can be attributed to the fact that eco-management accounting is still in its infancy. It takes learning time before the envisaged explanatory variables will be decisive on how eco-management accounting is to be shaped. Section 2.5 goes into a comparative analysis of the different sectors. Section 2.6 deals with the effects of company size on eco-management accounting.

2.5 A look into different sectors

2.5.1 Introduction

Section 2.5.2 to 2.5.5 discusses the results of the ECOMAC survey that provide insight into the effect of some sector characteristics on environmental management and management accounting. The following items are highlights and related to the different sectors:

- the technological nature of environmental measures in terms of prevention, reuse/recycling and end-of pipe;
- the presence of the different management systems in companies and their importance to environmental management (now and in the future);
- the allocation of environmental costs to overheads;
- the financial indicators used in informal and formal selection of (environmental) projects.

The sectors considered are: textile finishing companies, chemical companies, paper & printing companies (predominantly offset printing), metal plating and treatment companies, electronic companies and utility companies (predominantly electricity).

2.5.2 The technological nature of environmental measures

Table 2.5.1 makes clear that to a large extent environmental measures have become a matter of prevention. For all the sectors involved, the share of preventive measures ranges from 44 to 53 percent. Moreover, in four of the six sectors reuse/recycling takes the second place, albeit that the range is larger here (from 21 to 46%). The share of end-of-pipe measures is lowest among the electronic companies (8%).

Table 2.5.1 Environmental measures by nature of technology (percentage by sector)

Technological nature of Environmental measures	Textile companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Prevention	47	52	44	45	46	53
Reuse/recycling	24	30	42	33	46	21
End-of-pipe	29	18	14	22	8	26
Total	100	100	100	100	100	100

The prominence of prevention and reuse/recycling may partly explain the fact that management accounting is increasingly recognised as an important tool of environmental management. The more intensely measures have an impact on the primary process, the stronger they will affect a company's cost structure. Therefore, beyond information on the expenses associated with the purchase and maintenance of new equipment, there is a need to calculate the costs and benefits of the effects which a measure has on the production and distribution process and on the quality of the product. Such information requires the support of management accounting systems in order to have it available in time and at a reasonable cost.

2.5.3 Presence of environmental systems

In general, it appears that the companies in the various sectors make ample use of the various management systems. That means there are a variety of sources of information which may be relevant to environmental management. Management accounting systems have a strong position among the management systems (see Table 2.5.2).

Table 2.5.2 Management systems in operation or being implemented

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Quality management systems	86	100	71	82	88	89
Health & safety Systems	100	100	86	91	88	89
Environmental management systems	86	90	86	55	75	78
Materials requirements planning systems	100	95	43	82	100	100
Process/Job management systems	86	80	71	64	75	100
Management accounting systems	86	100	100	91	88	100
Financial accounting systems	71	100	100	73	75	78

Table 2.5.3 gives information on the relevance of the management systems to environmental management. In general, it can be said that in many companies management systems play a part in the management of environmental affairs. On the average, management systems are of the greatest importance to environmental management among the electronic companies, chemical companies and textile finishing companies. They are least important to environmental management in the sector of metal plating and treatment companies.

It is noticeable that in general the companies expect the importance of management systems to environmental management to increase in the future. Sometimes a system is expected to be less important, which can be explained by other systems taking over certain functions.

Table 2.5.3 Management systems: percentage of considerable importance or crucial to environmental management now

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Quality management systems	57	50	43	27	75	33
Health & safety systems	86	70	43	27	88	44
Environmental management systems	57	45	71	27	63	33
Materials requirements planning systems	29	45	28	9	38	44
Process/Job management systems	57	75	71	36	75	78
Management accounting systems	43	55	28	27	38	56
Financial accounting systems	28	45	28	18	25	44

It is striking that in the future for all sectors management accounting is expected to increase its significance to environmental management and, as Table 2.5.4 suggests, will, on the aggregate, be of equal or even higher importance to environmental management than environmental management systems. This conclusion supports the development of eco-management accounting as an academic subject and a tool of environmental management.

Table 2.5.4 Management systems: percentage of considerable importance or crucial to environmental management in the future

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Quality management systems	57	75	28	55	75	56
Health & safety systems	71	90	57	36	88	56
Environmental management systems	57	60	57	45	63	67
Materials requirements planning systems	43	60	28	36	50	11
Process/Job management systems	57	100	57	55	75	56
Management accounting systems	57	95	57	72	75	67
Financial accounting systems	14	65	48	18	50	44

The above results may also cast new light on environmental management itself. Many different management systems may play a crucial role in environmental management, and eco-management accounting can be assigned special tasks in integrating the information from the various sources. Moreover, eco-management accounting may look into the effectiveness, efficiency and costs of the environmentally-relevant information-providing functions available in a company. It would require additional research to define such new roles for eco-management accounting.

2.5.4 Management accounting's importance to environmental management

Tables 2.5.5 and 2.5.6 give further information on the importance of management accounting activities to environmental management. Table 2.5.5 refers to the present situation (now) and Table 2.5.6 to the future.

Table 2.5.5 reveals that at present management accounting is an important instrument in the management of environmental affairs, but there are remarkable differences. The chemical companies have high scores for all the different management accounting activities, whereas, for instance, the metal plating and treatment companies make much less use of management accounting as an environmental management tool. A fairly great variety in the degree of using an management accounting activity can be found under all activities.

Table 2.5.5 Management accounting activities: percentage of considerable importance or crucial to environmental management now

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Bookkeeping	50	75	40	29	13	22
Budget setting	67	90	20	20	63	44
Budget control	67	60	20	20	63	33
Capital budgeting	83	60	50	38	75	44
Product costing	33	100	0	60	38	33
Performance meas. Financial	50	95	50	0	63	56
Performance meas. non-financial	50	65	25	33	88	56

Table 2.5.6, however, makes clear that such differences are partly a matter of dynamics. It is noticeable, for instance, that with regard to budgeting and capital budgeting, the paper & printing companies as well as the metal plating and treatment companies are catching up. According to what environmental specialists in the companies expect, budgeting will substantially increase its importance to the environmental field. By and large, there is much opportunity for eco-management accounting in the coming years. However, company differences remain significant. There is room for research to find out which factors can explain such differences.

Table 2.5.6 Management accounting activities: percentage of considerable importance and crucial to environmental management in the future

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Bookkeeping	50	70	60	67	50	44
Budget setting	67	75	60	63	88	78
Budget control	67	90	60	75	88	67
Capital budgeting	83	70	67	75	75	78
Product costing	25	60	25	57	63	63
Performance meas. Financial	50	75	67	20	75	67
Performance meas. non-financial	50	90	25	16	75	67

2.5.5 Allocation of environmental costs

Table 2.5.7 makes clear that differences in cost allocation relate in part to the nature of the production process. The more prominent is a cost category, the greater is the chance that its costs are allocated directly to the processes or products concerned. This may explain, for instance, why a majority of textile finishing companies allocate energy and water costs directly to the process and product concerned whereas the printing companies treat them as overheads. Nonetheless, such factors cannot explain all differences in cost allocation. Other factors may relate to reporting traditions and different accountabilities, both internal and external. Also within sectors there are noticeable differences. Given the difficulty of explaining these differences, new research questions arise.

Table 2.5.7 Allocation always or mostly to overheads (percentage of companies per sector)

Cost categories	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
On-site inspections and control of air, wastewater and hazardous wastes	83	55	80	64	57	44
Testing and monitoring of emissions to air	83	60	50	45	50	87
On-side pre-treatment, treatment and discharge of wastewater	80	55	(67)	64	60	29
On-side pre-treatment, treatment and disposal of hazardous waste	50	45	25	55	67	13
On-side hazardous waste handling	100	60	83	64	83	0
Manifesting removal of Hazardous waste	100	60	80	64	83	0
Off-site hazardous waste transport	100	60	83	64	60	0
Off-site (pre)treatment of wastewater and hazardous waste	67	55	60	55	60	14
Energy costs	43	35	83	45	57	38
Water costs	43	40	83	55	57	17
Licensing	83	75	80	73	67	13
Reporting to public authorities	100	80	100	73	80	38
Environmental fines and Penalties	(100)	60	(100)	73	(75)	17
Training of staff how to comply with legislation	83	60	100	73	83	13
Time of environmental staff	83	90	100	82	83	75
Time of legal staff	(100)	90	(100)	73	(75)	78
Insurance costs	100	70	83	55	67	67

2.5.6 Indicators for the selection of environmental projects

Tables 2.5.8 and 2.5.9 show that the pay-back period is the most common indicator, followed by ROI. The chemical, utility and electronic companies tend to apply the greatest variety of indicators. 'Other' in Table 2.5.9 predominantly refer to combinations of indicators (pay-back period usually being one of them).

Table 2.5.8 Financial indicators used in informal investment appraisal procedures. Percentage of companies in survey using them (per sector)

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Pay-back period	71	80	57	67	88	56
ROI	28	45	28	22	63	67
NPV		30		11	25	67
Normalised NPV		5				11
IRR		30			25	44
ROTA		5			13	22

Table 2.5.9 Financial indicators used in formal investment appraisal procedures. Percentage of companies in survey using them (per sector)

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Pay-back period	71	5	57	55	25	22
ROI	14	25		9	38	11
NPV		20	14	11		11
Normalised NPV		20				0
IRR		20				55
ROTA						22
Other	14	5	28	36	38	22

Table 2.5.10 tells whether environmental projects are treated in the same way as other project. A distinction between compliance projects and voluntary environmental projects makes sense, also in terms of selection criteria. Table 2.5.10 suggests that the electronic companies more than the other sectors treat their environmental projects differently, whereas the utility companies seem to be inclined to deal with the selection of environmental projects in the same way as with other projects.

Table 2.5.10 Financial indicators and environmental projects (percentage of firms per sector)

	Textile finishing companies	Chemical companies	Paper & Printing companies	Metal plating and treatment companies	Electronic companies	Utility companies
Same indicator(s) are used for environmental projects, both compliance and voluntary	71	30	67	60	29	75
Same pay-back period for environmental projects	80	(100)	82	75	28	83
Same hurdle rates for environmental projects	25	92	-	75	50	100

2.6 Eco-management accounting and company sizes

2.6.1 The effect of company size on the usefulness of environmental management accounting

As shown in the previous chapters, management accounting can play an important role in the management of environmental affairs. Whether that is actually the case is expected to depend to some degree on company size. This is illustrated in Table 2.6.1.

Table 2.6.1 Importance of management accounting in meeting environmental challenges according to the company size. Percentage of firms involved

	Number of employees:			
	5 - 50	50 - 250	250 - 500	> 500
Firms that indicate that management accounting is important in meeting environmental challenges	50	75	82	47
Firms that indicate that management accounting is not important in meeting environmental challenges	50	25	18	46
Number of firms	10	24	11	39

Table 2.6.1 shows that 50 percent of the firms with 5 to 50 employees indicate that management accounting is important in meeting environmental challenges, whereas firms with 250-500 employees report a much higher percentage (82).

Larger firms tend to use formal management systems more often than smaller firms. For example, 60 percent of the firms that employ 5 to 50 persons have no quality management system. On this point the other size classes (50-250; 250-500 and more than 500) range between 10 and 20 percent. The importance of management accounting is expected to increase in all size-classes. The use of management accounting in firms with 5 to 50 employees is expected to move on in 50 percent of the firms. For firms with 250 to 500 employees this applies to all of them (100%). For those firms with more than 500 per-

sons, 63 percent of the firms expect the use of management accounting to increase. That the largest companies seem to depend less on management accounting in attending to their environmental affairs may be explained by the fact that they, more than others, have other systems in place which to some extent can perform the same functions. For example, all firms with more than 500 persons have a materials requirement planning system (MRPS) in operation or are implementing such a system. In the firms that have less than 500 employees the percentage of firms that have a MRPS is considerably less than 100 percent (see Table 2.6.2).

Table 2.6.2 The use of materials requirement planning systems (MRPS) according to the firm's size

	Number of employees:			
	5 - 50	50 - 25-	250 - 500	> 500
MRPS is not existent at firm	50%	25%	36%	0%
MRPS is in operation at firm	40%	67%	64%	95%
MRPS being implemented at firm	10%	8%	0%	5%
Number of firms that belong to size-category	10	24	11	39

In all sectors there are companies who have integrated environmental aspects into their business economic objectives. However, company size seems to influence the extent to which environmental aspects are integrated into these objectives. Of the companies with more than 500 employees, 70 percent have experienced such an integration. Of the companies with only 5 to 50 employees, the corresponding percentage is only 33 percent.

Table 2.6.3 shows that 71 percent (44.1 + 26.5) of the firms with more than 500 employees have an environmental staff to deal with environmental issues. Of the smallest firms, only 12.5 percent have an environmental staff department.

Table 2.6.3 The organisational structure to deal with the environment according to the firm's size

	Percentage of firms that have or have not an organisational provision to deal with the environment, in different size categories: Number of employees:			
	5 - 50	50 - 250	250 - 500	> 500
Environmental staff	13%	32%	40%	44%
Environmental responsibilities integrated into line organisation	13%	27%	30%	29%
Environmental responsibilities integrated into line organisation assisted by an environmental staff department	0%	18%	20%	27%
No organisational adaptations to deal with the environment	75%	23%	10%	0%
Number of firms that belong to size-category	10	24	11	39

With respect to environmental management accounting, the role of an environmental staff department seems to be quite important. It appeared that the environmental departments of the firms included in the survey were involved in developing environmental management accounting systems.

2.6.2 The technological nature of environmental measures

Table 2.6.4 shows that to a large extent environmental measures have become preventive in nature, irrespective of company size. For all categories, the share of preventive measures ranges between 48 to 51 percent.

Reuse/recycling measures are less prominent. The share of these measures ranges from 17 to 36 percent. The share of end-of-pipe measures ranges from 16 to 32 percent.

Table 2.6.4 Environmental measures by nature of technology (percentages)

Technological nature of environmental measures	5 - 50	50 - 250	250 - 500	> 500
Prevention	51	48	50	49
Reuse/Recycling	17	36	33	31
End-of-pipe	13	16	17	20
Total	100	100	100	100

The high share of preventive measures for all size-classes may imply that management accounting has increasingly been used as a tool of environmental management, on the premise that the closer that measures are to the business's primary processes, the more strongly they are likely to impinge on the company's cost structure. This is what happens when preventive technologies are implemented. However, a deficient cost accounting system may encourage the use of other management systems as sources of information and decision support.

2.6.3 Presence of environmental management systems

Management accounting systems are amongst the systems which are most frequently implemented. The percentage of firms that use these systems range from 80 to 100 percent (see Table 2.6.5). Therefore, management accounting systems belong, together with Health and Safety, Process/Job management and Financial accounting systems, to the most commonly used management systems. All these systems have a score of 60 percent or more.

Table 2.6.5 Management systems in operation or being implemented (percentage of number of firms in size-class)

	5 - 50 (n = 10)	50 - 250 (n = 24)	250 - 500 (n = 11)	> 500 (n = 39)
Quality management systems	40	96	91	95
Health & Safety Systems	80	88	91	95
Environmental Management Systems	40	75	91	90
Materials Requirements Planning Systems	50	75	64	100
Process/Job Management Systems	60	67	73	74
Management Accounting Systems	80	92	100	97
Financial Accounting Systems	90	83	100	85

Generally, management accounting systems have a broader audience than do environmental management systems. According to Table 2.6.6, in size-class 250-500 management accounting already is very important to environmental management for a majority of the firms. In the future this will be the case for all size-classes except for firms with less than 50 employees (see Table 2.6.7).

Table 2.6.6 Management systems: percentage of firms that perceive them to be of considerable Importance or crucial to environmental management now (percentage of number of firms in size-class)

	5 - 50 (n = 10)	50 - 250 (n = 24)	250 - 500 (n = 11)	> 500 (n = 39)
Quality management systems	20	46	73	49
Health & Safety Systems	30	42	73	67
Environmental Management Systems	20	58	73	72
Materials Requirements Planning Systems	20	25	45	46
Process/Job Management Systems	10	29	45	36
Management Accounting Systems	10	42	64	46
Financial Accounting Systems	0	29	73	36

It is striking that small firms (5-50 employees) do not expect an increase in the importance of environmental management systems in the future. However, these firms expect the importance of management accounting to environmental management to increase in the future (compare Table 2.6.6 and 2.6.7: now 10 percent, future 50 percent).

Table 2.6.7 Management systems: percentage of firms that perceive them as of considerable importance or crucial to environmental management in the future (percentage of number of firms in size-class)

	5 - 50 (n = 10)	50 - 250 (n = 24)	250 - 500 (n = 11)	> 500 (n = 39)
Quality management systems	30	54	73	67
Health & Safety Systems	40	58	73	72
Environmental Management Systems	20	71	82	74
Materials Requirements Planning Systems	30	29	55	62
Process/Job Management Systems	30	38	45	49
Management Accounting Systems	50	71	91	77
Financial Accounting Systems	0	42	82	46

2.6.4 Management accounting's importance to environmental management

Table 2.6.8 and 2.6.9 provide more insight into the importance of management accounting activities to environmental management. Table 2.6.8 refers to the present situation and Table 2.6.9 to the future (expectations of the companies in the survey).

Table 2.6.8 Management accounting activities: percentages of firms that indicate that an element of the management accounting is presently of considerable importance or crucial to environmental management (percentages of companies in size-class)

	5 - 50	50 - 250	250 - 500	> 500
Bookkeeping	0	44	36	35
Budget setting	29	25	78	56
Budget control	29	25	89	54
Capital budgeting	38	65	73	65
Product costing	80	33	14	55
Performance measurement (financial)	17	33	89	58
Performance measurement (non-financial)	40	50	90	56

Table 2.6.9 Management accounting activities: percentages of firms that indicate that an element of the management accounting will be of considerable importance or crucial to environmental management in the future (percentages of companies in size-class)

	5 - 50	50 - 250	250 - 500	> 500
Bookkeeping	33	75	70	54
Budget setting	57	72	80	78
Budget control	57	78	90	81
Capital budgeting	50	85	82	89
Product costing	63	47	71	71
Performance measurement (financial)	33	56	89	82
Performance measurement (non-financial)	20	54	90	77

Table 2.6.8 and 2.6.9 confirm what had already been observed before:

- most management accounting activities will increase their importance to environmental management in the years to come;
- in general, the use of management accounting for environmental purposes increases with company size, but the largest companies (>500 employees) tend to moderate this trend.

Smaller firms attach a greater value to cost pricing in the environmental field than the bigger ones. A possible reason for this is that smaller firms have to face the product price as a limitation to what they can afford. Increases in the product costs can only be acceptable if this can be covered by the product price. In the future product costing will gain in importance for the larger firms. These business opportunities may be decisive rather than compliance with external requirements, which is tantamount to making costs and benefits figures prominent indicators.

2.6.5 Allocation of environmental costs

Table 2.6.10 makes clear that differences in cost allocation for a part relates to the size of a company. Larger firms tend to allocate environmental costs less frequently to overheads than do smaller firms. For example 100 percent of small firms (5-50 employees) allocate always or mostly costs of on-site hazardous waste handling to overhead. For larger firms (> 500 employees) this percentage is only 54 percent.

Table 2.6.10 Allocation always or mostly to overheads (percentages of companies in size-class)

Cost categories	5 - 50	50 - 250	250 - 500	>500
On-site inspections and control of air, wastewater and hazardous waste	88	70	60	58
Testing and monitoring of emissions to the air	100	41	73	60
On-site pre-treatment, treatment and discharge of wastewater	100	79	70	47
On-site pre-treatment, treatment and disposal of hazardous waste	88	59	46	47
On-site hazardous waste handling	100	83	73	54
Manifesting removal of hazardous waste	89	82	70	54
Off-site hazardous waste transport	88	78	80	53
Off-site (pre-)treatment of wastewater and hazardous waste	100	83	50	54
Energy costs	90	81	46	35
Water costs	89	59	64	65
Licensing	89	82	90	60
Reporting to public authorities	86	93	91	78
Environmental fines and penalties	100	90	100	78
Training of staff how to comply with legislation	100	94	100	77
Time environmental staff	100	100	100	87
Time legal staff	100	90	100	87
Insurance costs	100	90	100	88

2.6.6 Indicators for the selection of environmental projects

Tables 2.6.11 and 2.6.12 indicate that for smaller firms pay-back period is the most commonly used indicator. The larger firms use IRR most frequently, with pay-back period and NPV in second and third place. In addition to these regular financial indicators other indicators are used. These tend to be firm-specific and qualitative in nature.

Table 2.6.11 Financial indicators used in informal investment appraisal procedures. Percentage of companies in survey using them (in size-class)

	5 - 50	50 - 250	250 - 500	> 500
Pay-back period	60	84	100	71
ROI	40	21	40	58
NPV	10	0	20	29
Normalised NPV	10	0	0	5
IRR	0	5	10	32
ROTA	0	0	0	11

Table 2.6.12 Financial indicators used in formal investment appraisal procedures. Percentage of companies in survey using them (in size-class)

	5 - 50	50 - 250	250 - 500	> 500
Pay-back period	50	54	27	21
ROI	10	13	27	13
NPV	0	4	9	13
Normalised NPV	0	0	0	0
IRR	0	4	0	24
ROTA	0	0	0	0
Other	40	25	37	29

Table 2.6.13 tells whether environmental projects are treated in the same way as other projects. This table indicates that the distinction between environmental and non-environmental investments affects the capital budgeting process. There is an indication that the size of company affects the way a company deals with this distinction between projects: firms with 250 to 500 employees more often use different thresholds for environmental projects than firms with more than 500 employees.

Table 2.6.13 Financial indicators and environmental projects (percentage of firms in size-class)

	5 - 50	50 - 250	250 - 500	> 500
Same indicator(s) are used for environmental projects, both compliance and voluntary	56	52	36	61
Same pay-back period for environmental projects.	71	56	36	57
Same hurdle rates for environmental projects.	67	56	33	74

2.7 Conclusions and recommendations for research

2.7.1 Conclusions

The survey's main objective is to explore to what extent management accounting already plays a part in environmental management. 94 percent of the firms that were interviewed use or implement management accounting systems. 43 percent of the firms reported that the management accounting systems are of considerable importance or crucial to environmental management.

In the future, for 74 percent of the companies management accounting will reach that high level of importance. Particularly, performance measurement and product costing will cause that increase.

Country-specific legislation on external reporting seems to stimulate management accounting. Sector-related factors as well as company size are influential factors, but company-specific practices seem as yet to be dominant in establishing the role of management account in the management of a company's environmental affairs. The latter most likely reflects the early stages of a learning process that eco-management accounting is going through.

A factor that affects the use of management accounting is the type of environmental measures which a firm takes. For all sectors involved, the share of preventive measures ranges from 44 to 53 percent. The prominence of prevention and reuse/recycling may partly explain the fact that management accounting is increasingly recognised as an important tool of environmental management. The more intensely measures have an impact on the primary process, the stronger they will affect a company's cost structure. Cost information is to be generated by management accounting in order to assess investments in preventive measures. However, the information on how to assess environmental management is also provided by other management systems than management accounting. On the average, management systems are instrumental to environmental management, particularly among the electronic companies, chemical companies and textile finishing companies. In the future for all sectors management accounting is expected to increase its significance as a tool of environmental management.

Another important factor that determines the need for environmental information generated by management accounting is related to the nature of the production process. The more prominent a cost category, the greater will be the chance that the costs involved are directly allocated to products and processes. As environmental effects are internalised and environmental costs expand, the identification of the true cost drivers becomes a crucial part of eco-management accounting for environmental purposes.

The major impact of the size of the company on the link between environmental management and management accounting lies in the fact that smaller firms tend to use less formal management systems, such as management accounting. In addition, smaller firms

tend to have little resources to adapt accounting systems or develop new ones to provide management information in a structured manner.

2.7.2 Recommendations for further research

The survey shows that many different management systems may play a crucial role in environmental management. One role for eco-management accounting is to integrate the information from these various sources. Moreover, eco-management accounting may look into the effectiveness and efficiency of environmental measures. The interplay of the different management systems relevant to environmental management may create a new perspective towards eco-management accounting. That means that along with an expansion of traditional management accounting tools, the building of new multi-system models of eco-management accounting becomes a promising new field of research. Also, eco-management accounting should provide guidelines on how one can re-design existing accounting systems and develop new ones. An important aspect is the assessment of the benefits and the costs of eco-management accounting systems and techniques. It would require additional research to map such roles of eco-management accounting.

The survey indicates that in the field of eco-management accounting there are significant differences in scope and practice. There is a need for research to find out which factors can explain such differences. In the coming years the implementation of eco-management accounting will mature. This process can be promoted by further research into how eco-management accounting can be effectively developed, contingent upon a variety of actors and factors determining a firm's economic conditions and informational needs.

An important issue is the way how small and medium-sized companies can be stimulated to use both environmental management systems and eco-management accounting systems. For the larger firms the integration of the management accounting systems with other management systems is an important issue. Such integration will determine the efficiency and effectiveness of eco-management accounting in industry.

3 Developments in eco-management accounting: an analysis of the case studies

Jan Jaap Bouma
Teun Wolters

3.1 Introduction

The project's 15 case studies have been done to throw light on what companies have actually undertaken to produce figures of costs and benefits which may help to improve their environmental decision-making. Moreover, several case studies indicate how eco-management accounting can be set up and enhanced. The four Dutch case studies also involved the development of eco-management tools which required extensive empirical research within the companies concerned. These companies, therefore, participated as associated partners in the project.

Before going into the case studies themselves, this chapter focuses on the nature of the companies involved, their environmental challenges and how they have organised the management of their environmental affairs (section 3.2). Then, it analyses what the case studies contributed to the project in terms of the kinds of eco-management issues addressed and the incentives and barriers in developing eco-management accounting, as well as the major themes of the case studies (section 3.3). Section 3.4 discusses the immediate contexts of the case studies and the results in terms of concrete developments of eco-management accounting, and Section 3.5 draws conclusions.

3.2 Nature of the companies

Size and organisational structure

Most companies studied appear to be rather large; this means they had at least several hundred employees. Moreover, almost all of them are subsidiaries to a large-scale international corporation. By characterising them in this way, two major variables of an advanced position in eco-management (accounting) seem to have been detected: size and belonging to a wider organisation (in a number of cases, the mother company is settled in the US). Both variables relate to a greater need for management support, accountability and formal procedures. Moreover, large-scale operations may make even modest cost drivers worth dealing with, if there is sufficient motivation to do so.

Considering these arguments, the position of large companies in eco-management accounting partly is a matter of being among the forerunners. To that extent, it can be expected that other companies will follow sooner or later. However, the role of the large companies may be so strongly related to size that smaller companies cannot be expected to join them, neither as early adopters nor as laggards. This particularly applies to the va-

riety of management systems and supporting functions which large corporations tend to have.

Sector

Also the kind of sector indicates which kind of companies will be relatively inclined to develop eco-management accounting. The following companies were involved.

1. Chemical companies		
C1	one producing health-care products	UK/Ireland
C2	one producing herbicides and pesticides	UK/Ireland
C3	one producing synthetic resins	NL
2. Electronic companies		
E1	one producing photocopiers	UK/Ireland
E2	one re-manufacturing and distributing photocopiers	NL
E3	one providing telecommunication services	UK/Ireland
E4	one producing semiconductor integrated circuits	IT
E5	one producing information processing products	DE
E6	one distributing audio-visual sets	DE
Other companies		
O1/O2	two producing paper specialties	NL/IT
O3	one producing bed furniture	NL
O4	one producing glass for monitors	DE
O5	one exploring and producing crude oil	IT
O6	one distributing petrol	IT

Environmental effects and challenges

The environmental challenges which the companies are facing can be summarised as follows. The chemical companies usually have elaborate programmes to reduce and control their environmental effects.

Chemical companies confront a great variety of environmental effects, such as hazardous and non-hazardous wastes, contaminated land, emissions to the air, water and soil, and product packaging. Environmental challenges may be minimisation of product packaging, further energy efficiency, effective waste reduction strategies, increasing recycling of discarded equipment, and risk control of spills.

Electronic companies also confront different kinds of environmental effects, such as solid waste (*inter alia* paper, replaced equipment, cables, batteries), emissions to the air, wastewater, energy, noise and risky chemicals, and fuel of own car park. Environmental challenges may be minimisation of waste, zero landfill, and increased reuse of equipment.

The environmental effects of the other companies are: process water, energy, emissions to air, solid waste from wood and metal components, risks of oil spills, water consumption,

packaging, and product toxicity. Their environmental challenges include an objective of being perceived in the marketplace as the green paper company, and further development of an environmental management system.

Environmental management
Most companies studied have developed extensive environmental management structures. These can be indicated as follows (see Table A).

The presence of an advanced level of environmental management could induce the development of eco-management accounting. However, it seems that in most cases eco-management accounting is getting attention late if compared to other tools of environmental management. This affirms that environmental management has developed as a relatively isolated function. Eco-management accounting has a chance of taking off only when general management is interested in the environmental aspects of the company's activities.

3.3 Issues of eco-management accounting

3.3.1 The need for cost control

Today the strategic decisions which companies have to make cannot be simply characterised as a choice between low costs and high quality. The present trend of globalisation encourages companies to control and reduce their costs under all circumstances. That also applies to environmental management. The road towards the sustainable enterprise is long and will require continuous improvements for a long time to come. This can be done only if environment is fully integrated in the main stream of business. That means that environmental aspects have to be considered in all business decisions, both strategic and operational. One major issue will always be the control and containment of the environmental costs attached to a company's activities. For that matter, it is important for companies to know their environmental costs. All the case studies, in different ways, deal with these. This chapter highlights a number issues related to the accounting of environmental costs which played a part in the case studies.

Table A Artefacts and Stated Policies of Environmental Management

C1 several intra-company environmental awards first to meet the corporation's environmental targets accreditation with ISO 14001	E1 constant quality improvement successful re-use programme corporate environmental leadership programme accredited systems	O1 sector agreement (*inter alia* on water) preparing for future demands (recycled paper)
C2 safety, health and environmental guidelines each site has an EMS each CEO reports environment to Executive Board	E2 leading in environmental management and reporting continuous improvement record in waste minimisation	O2 green products as marketing policy advancement in the use of environmental tools (such as env. programme, env. balance sheet, LCA and env. accounting reports
C3 each plant has an environmental co-ordinator environment considered in investment and technology plans environmental reports to headquarters	E3 integrated HSE model continuous improvements audits and certifications	O3 environmental co-ordinator cleaner technology investments environmental aspects in quality management
	E4 proactive env. management related to quality management env. tools applied (EMS, env. balance) and reporting (progress reports, monthly material flows)	O4 EMS according to ISO 14001 environment considered in all aspects
	E5 corporate policy on safety, environmental protection and conservation env. tools applied (LCA, EIA) ISO 1400l and some EMAS	O5 follows group guidelines for a proactive strategy there is an environmental information programme in support of an EMS, report and auditing
	E6 EMS under ISO 14001 employee involvement	O6 environment considered in all strategies environmental tools are EIA and env. balance sheet

3.3.2 Corporate incentives

The case studies show that existing accounting and reporting procedures in multinational corporations may promote activities to track environmental costs. There may be a range of environmental reporting directed to different levels. Moreover, in a company there may be a general drive to charge costs to the departments causing them. In particular, activity-based costing may serve to improve environmental cost information and highlight saving opportunities.

Where such a development can be observed, a more elaborate tracking of environmental costs may be achievable without major difficulty. In fact, it may mean that the polluter-pays principle is also used as a guideline for cost accounting within business organisations rather than as a principle restricted to trade relations.

Incentives may also lie in certain initiatives taken at corporate headquarters. Baxter's environmental financial statement is an example. It started at corporate level and was later adopted by one of their production facilities. Chain-related cost advantages may also need the involvement of the corporate level as individual business units cannot oversee or organise a chain which goes beyond their responsibility. The Xerox UK case exemplifies this. All logistics costs were incurred and captured at operating companies, but they were also pulled through to the centre who then looked for possible opportunities for cost savings and operational improvements. This made it possible to look at the packaging aspects throughout the logistics chain by which products reach the customers, leading to a new 'tote' system by which waste streams could be reduced and money could be saved.

In general, total quality management may also be an incentive to have a fresh look at costs. At Xerox, quality costing principles inspired a critical look at the packaging procedures. Previously, there were 23 different pallets and pack sizes. To date, two standard totes have replaced all other packaging, while depalletising time was strongly reduced.

3.3.3 Other incentives

There may be other incentives. In particular, larger companies may confront a considerable number of stakeholders who all require the provision of certain information on a company's environmental performance. 'Different costs for different purposes' may be a correct principle, but the company must keep track of them and be able to tell what the conceptual and algorithmic differences are. In order to keep things manageable, it may be decided to develop one coherent system of environmental cost accounting which can serve the different purposes, including external reporting. The rise of integrated information systems may also help environmental cost information to be available in a systematic and effective way.

3.3.4 Possible barriers

A cultural gap

Current practices may also discourage the collection of environmental costs. Environmental management has usually started as a separate function within a company, in particular to deal with environmental regulations and the authorities responsible for their implementation. Because of this, in many cases there is a cultural gap between the environmental specialists and the accounting specialists in one and the same company. Eco-management accounting requires the co-operation of the two. Environmental specialists have access to much relevant environmental data, but this has to be integrated in the accounting procedures by the accounting specialists (such as controllers and accountants). Only if general managers accept full responsibility for the company's environmental performance, can the aforesaid gap be closed.

Lack of environmental pressure

A general disincentive may be a lack of environmental pressure as a result of which environment deserves a higher priority in the company's decision-making procedures. For many companies, compliance with existing legislation and related regulation is the major environmental objective. Issues concerning environmental costs may then also arise, but the number of options are likely to be fairly limited. Only when environment is taken on board as a strategic issue, environmental options (beyond compliance) increasingly require an economic underpinning.

Decentralised organisation

In companies who are strongly decentralised, management accounting may be mostly done at a local level, often using different cost definitions. In order to collect compatible figures, it is necessary to have uniform definitions. Moreover, seeking the co-operation of many people throughout the corporation might be a hard job to do.

Official cost definitions

For their internal environmental cost reporting, companies may follow the criteria of their national statistical office (or EUROSTAT), to which they regularly send information as input to the country's environmental statistics. The statistics may help to make environmental costs figures available. However, they may also be an impediment to business-oriented thinking, as the statistical definitions focus on consistency on a national level but do not necessarily consider company-based interest. For instance, environmental measures may be relevant to a company even though they are confined to a plant's territory, or be linked up with other business interests such as health and safety, or time-to-market. Moreover, environmentally focused investment may be profitable according to economic selection criteria such as NPV or ROI.

The financial underpinning of environmental measures increasingly requires an approach which is systematic and pragmatic at the same time. For that purpose it is necessary to connect existing management accounting systems with environmental management systems. The lack of connection between environmental decision making and management accounting (laying emphasis on costs and benefits) is responsible for a number of problems which comprise a serious impediment to the integration of environmental aspects into the mainstream of entrepreneurial concerns. Generally, the relevant problems are:

- insufficient and ineffective access to relevant data;
- available data are not suitable to address the problems involved:
  - present management-accounting systems neglect or ignore relevant data. Other management systems (like an environmental management system) that can provide relevant data on environmental costs are neglected by those persons responsible for management accounting;
  - a lack of knowledge to deal with and remedy these shortcomings.

The 15 case studies provide an insight into the above-mentioned problems as they are identified from the perspective of the management of these firms. The case studies cover a variety of eco-management accounting themes, including 'costs of environmental management', product costing, waste minimisation, environmental costs in product development and end-of-life disposal costs. An eco-management accounting theme of a case study may focus on a mix of management accounting problems relevant to environmental management.

With respect to Germany, table 3.3.1 provides an overview of the themes and management accounting problems that occurred in connection with these themes.

Table 3.3.1 Germany. Themes and management accounting problems addressed

Firm	Theme of the case study	Management accounting problems
IBM Deutschland	The management of the end-of-life disposal of computers	– Dealing with changing information needs within a company: the fulfilment of a new information need (related to decision making to meet end-of-life objectives). – The potential shortcomings of reliance on historic data for future-oriented decision-making.
Philips Deutschland	Providing data on environmental costs for external pressures (largely governmental requirement that companies provide environmental cost data). Also, internal cost control is addressed.	– Specifying overhead (the shortcomings of existing cost allocation systems);
Sony Deutschland	Providing data on environmental costs and generate information for effective (environmental) cost control.	– The proper allocation of end-of-life take-back and packaging disposal costs. – Providing the management responsible for design and production with relevant data that results in outcomes of decision making processes that control and reduce environmental impacts.

The German cases show that the management accounting problems are not confined to the development of new accounting systems and techniques that address environmental costs and financial benefits of environmental management. Also, the organisational issues are recognised: an appropriate organisational context is needed to ensure effective actions. In the Sony case it is found that key decisions about product packages are taken outside Germany where costs information is generated. Potential mismatches between the information need at the responsible management and the organisational units that generate information on environmental costs should be prevented. Without a solid information need for environmental costs, the generation of this information may be unproductive. The management should be aware of environmental problems and acknowledge the need to deal with these problems.

With respect to Italy, table 3.3.2 provides an overview of the themes and management accounting problems that occurred in connection with these themes.

Table 3.3.2 Italy. Themes and Management accounting problems addressed in the cases

Firm:	Theme of the case study	Management accounting problems
Cartiera Favini	The allocation of environmental costs and benefits for cost control and capital budgeting.	– Specifying overhead (the shortcomings of existing cost allocation systems); – The use of investment appraisal techniques that do not adequately account for future environmental costs and benefits.
SGS-Thompson Microelectronics	The significance of hidden environmental costs in a company with a well developed quality culture.	– Specifying overhead (the shortcomings of existing cost allocation systems);
AGIP SPA	The calculation of liability costs and allocation of environmental costs for cost control.	– Specifying overhead (the shortcomings of existing cost allocation systems); – Calculation of future environmental liability costs. – Categorisation of costs into variable and fixed cost categories.
Italiana Petroli SPA	The calculation of liability costs and allocation of environmental costs for cost control and investment appraisal.	– Specifying overhead (the shortcomings of existing cost allocation systems); – Calculation of future environmental liability costs.

With regard to the Italian cases it is noticed that the problems of eco-management accounting concentrate on the calculation of environmental costs with an emphasis on liability costs. The management of the firms regard the liability cost to be highly relevant to their decision making. The context of environmental management in which the management accounting problems are addressed is stimulating. An important stimulus is the widespread use of environmental balance sheets.

With respect to the United Kingdom and Ireland, Table 3.3.3 provides an overview of the themes and management accounting problems that occurred in connection with these themes.

Table 3.3.3 United Kingdom and Ireland. Themes and management accounting problems addressed

Firm:	Theme of the case study	Management accounting problems
Baxter Irish Manufacturing Operations	The quantification of financial costs and benefits of environmental activities with respect to a corporate 'environmental financial statement'.	- Initial data collection on environmental costs and benefits; - Improving the credibility of environmental costs and benefits figures. - Improving the cross-functional relationships (including the environmental function) in the process of generating information.
Xerox, UK	Packaging initiatives developed by a cross-functional Quality Improvement Team	- Analysis of costs over the chain and sub-chain financial analyses; - Dealing with changing information needs within a company: the fulfilment of a new information need (related to decision making packaging). - The use of support systems whose data can be used for multiple information needs; - the balance between planning and control at a central upper management level and more decentralised planning and control.
Zeneca	Waste minimisation	- Calculation of waste costs. - The role of an accounting department in the process of generating management information.
XYZ	Using appraisal techniques for the assessment of products	- The calculation of internal and external environment-related costs; - cost-effective procedures to gather environmental data for life-cycle costing.

The cases in the UK and Ireland show that besides the problems of having appropriate techniques to generate adequate information on environmental costs, there is also a need for cost-effective means to gather data on environmental impacts. This is an especially crucial problem when analyses of costs over the operations chain are performed. The data availability for sub-chain financial analyses is often adequate. This is often the result of using the data from other management systems such as the production logs, etc., which are generated by production processes management systems. Also, the UK/Irish

cases show that organisational factors can be crucial for effective eco-management accounting within the firms. The role of the accounting department should not be overestimated, since other functions and departments can also play crucial roles. The organisational setting for using eco-management accounting techniques is an important problem of environmental management.

With respect to the Netherlands, table 3.3.4 provides an overview of the themes and management accounting problems that occurred in connection with these themes.

Table 3.3.4 The Netherlands. Themes and management accounting problems addressed

Firm:	Theme of the case study	Management accounting problems
Meerssen Papier	The significance of environmental costs and its reason for cost control	– The allocation of environmental costs that are part of overhead.
Xerox NL	Significance of standard cost prices and transfer prices in optimising take back policies	– The allocation of environmental costs to reused products (product costing).
Hercules NL	Increasing transparency of environmental costs, and analysing the differences between environmental costs of different sites.	– Calculation of environmental costs using different calculation models. – Using the Model of Environmental Costs (MEC);
Auping NL	The effect of preventive measures on environmental costs.	– Using the Model of Environmental Costs (MEC) for calculating environmental costs; – The financial assessment of environmental measures.

The cases in the Netherlands focus on the development and use of eco-management accounting techniques. One technique which was used and tested serves to determine the economic attractiveness of preventative measures. The problems refer to new information needs for which an management accounting approach based on quality management ideas is applied which is new to the firm.

3.4 Eco-management accounting

The former section provides an overview of several management accounting problems presented in the case studies. This section analyses how the case firms address these accounting problems by developing their eco-management accounting instruments.

3.4.1 The context of Eco-management accounting

The case studies indicate that how firms deal with eco-management accounting problems is firm-specific. Three important contextual variables are the processes, the culture and the structures within an organisation.

The importance of processes can be illustrated for both the technological processes (such as production process) and organisational processes such as the strategic and operational decision-making processes. The type of production process directly influences the design and use of accounting systems. For example, the degree of cost allocation, and the method used, depends on the type of production process involved. If only one type of product is produced, the allocation of overheads is less arbitrary than when different types of products are produced. The more a firm manages the life cycle of its product, the more the accounting system tends to cover the life-cycle costs. The kind of decision-making processes will largely determine the need for cost information. A broad distinction can be made between strategic and operational decision-making.

The culture within a firm directly affects the development of eco-management accounting. It was previously mentioned that the cultural gap between the environmental specialists and the accounting specialist may impede the development of eco-management accounting as it requires the co-operation of the accounting specialist and the environmental specialist.

The impact of organisational structures on accounting is reflected by the development of eco-management accounting. The organisational structure refers to how a firm and its management systems have been organised.

The case studies provide insight into the ways in which companies work, under different conditions, on solutions for management accounting problems related to environmental management. Table 3.3.5 shows what developments in eco-management accounting are highlighted by the German case studies. The same overviews are given for Italy, the UK (and Ireland) and the Netherlands in Tables 3.3.6, 3.3.7 and 3.3.8.

Table 3.3.5 Development in eco-management accounting in the German case studies

	Eco-management accounting development
Philips	An approach is considered that identifies environmental costs and allocates these costs to processes and products. The approach starts with defining environmental costs and identifies those cost items that form the total environmental costs.
IBM	No general definition of environmental costs. Costs of environmental activities are calculated for specific purposes. The case studies illustrate this in relationship to the take-back of used computers. In this respect, environmental costs can be those costs of a complete site. ABC is used to allocate costs and hitherto also environmental costs.
Sony	Environmental costs are considered in the regular controlling and bookkeeping system and are part of the profit and loss statement. The term 'environmental costs' covers different kinds of cost items.

Table 3.3.6 Developments of eco-management accounting in the Italian case studies

Firm	Eco-management accounting development
Cartiera Favini	Use of an environmental accounting system with same structure as the quality cost system.
SGS-Thompson Microelectronics	Environmental investments are judged in a separate way. Environmental investments do not need to comply with usual financial criteria. An approach to get a better overview of environmental costs is considered. This approach contains the following steps: 1. Identify environmental impacts; 2. Identify measures taken to reduce these effects and their costs (conventional costs); 3. separate costs made for compliance and those costs made for going beyond compliance; 4. identify environmental costs for environmental policy in general.
AGIP SPA	Preparation of environmental balance sheets. Environmental costs are defined according to EUROSTAT. The environmental costs are subdivided between operational and capital costs, and are collected at operational level and thereafter aggregated at corporate level.
Italiana Petroli SPA	Follows the EPA definitions of conventional environmental costs, except for labour costs in some cases. IP adopted a new accounting system for environmental costs. Some environmental costs have specific accounts. The accounts are also used for budgeting and control. No strict procedures for investment decisions. Common criteria are used, such as Return on Assets, Return on Investments, Net Present Value, and Internal Rate of Return.

Table 3.3.7 Developments of eco-management accounting in the British and Irish case studies

Firm	Eco-management accounting development
Baxter	There is a range of regular performance reports for different management levels. ABC is introduced to improve cost information and highlight saving opportunities. However, environment-related costs are not routinely charged back to the processes creating them; disposal costs are tracked in total. Only physical waste streams are tracked, as are all recycled materials. The Environmental Financial Statement (EFS) distinguishes between costs of the proactive programme, remediation and waste disposal.
Xerox	Logistics costs are measured at company level. For the first 3 years this could be done only by means of questionnaires and direct inquiry. Now it is incorporated into the ledger coding system and it is part of the regular management information. As a result of this information, the logistic costs are minimised. Life cycle costing and quality costing principles are used.
Zeneca	As general policy costs are allocated to businesses as accurately as possible, to create cost awareness (polluters-pays principle at a company level).
XYZ	XYZ is leading in environmental management and reporting. Minimisation of waste by continuous improvement. Practical tools to consider environment in design and product development. Evaluation of environmental accounting, 3 evaluation techniques, data needed for Eco-costing

Table 3.3.8 Developments of eco-management accounting in the Dutch case studies

Firm	Eco-management accounting development
Meerssen Papier	In pre-process (making of pulp and paper) cost dividers are machine hours, amounts of paper produced. Resembles a Process Costing System. In the next phase (refining of raw paper) an ABC system at unit level is used (costs are calculated on the basis of the jobs (processes) that a batch undergoes. Resembles Job Costing System.
Xerox	There is not yet an overall information system that connects the environmental costs of all the departments with each other. This limits the use of available data
Hercules	There is an environmental reporting process to the European headquarters and subsequently to the US headquarters. That report includes environmental liabilities, progress on clean up and emission reduction efforts. A limited amount of environmental costs are included. The case study focused on how to improve the present management accounting system so as include the costs and benefits of environmental measures.
Auping	The case study is conducive to the development of a cost tool as part of an evolving environmental management system. Case involved second measurement of preventive and curative environmental costs (first measurement 1990) according to available model for environmental costs (MEC). MEC is an additional instrument to measure the quality of a company's environmental management.

3.4.2 The fields requiring eco-management accounting

Tables 3.3.5 to 3.3.8 show that the case studies cover different developments in eco-management accounting. Some of the developments provide possible solutions to management accounting problems, whose implementation is not decided upon. In these problem- mapping cases, an eco-management accounting solution has been suggested but the firm is still in the process of assessing the options, also in terms of their costs and benefits.

Although most cases deal in one way or another with tracking environmental costs, the reasons to do this are diverse. Some important activities that ask for eco-management accounting tools are:

1. The future proofing of investments;
2. Understanding and managing environmental costs;
3. Developing products;
4. Improving environmental performance.

In the decision-making processes that pertain to strategic investments such as the production and introduction of new products, the accurate calculation of cost prices is crucial. Even though, in general terms, a company may profess a correct allocation of costs to

products or product groups, environmental costs may be exempted. In one of the companies studied, the costing of internal services was not optimal. The allocation of heating costs, for example, was independent of the actual heating. As a result, there was no incentive to save energy. In the same company, end-of-life costs (such as for disposal and recycling) were not collected and consequently not allocated correctly.

The selection of investments is part of the capital budgeting process. In this process an investment assessment takes place and sometimes external effects are explicitly estimated in order to assess all relevant impacts of an investment on the environment.

The ECOMAC survey shows that many companies pay attention to the external effects of their investment. However, monetary valuation of these effects is still rare. A few companies - in particular, larger companies - may use monetary valuation of external effects as a means to assess potential future environmental costs which are not yet actually incurred by the individual company. Another reason for valuing external effects lies in the ease of communication about a company's environmental burden with different kinds of stakeholders. Valuation usually produces only rough estimates, which may be a problem in aggregating and weighting different figures.

As well for managing environmental costs, ABC can be of importance. However, other accounting methods can be also used in this respect. Although the bookkeeping system is a crucial source of cost information, additional sources of information may be needed. Such other sources are, for instance, management tools to control the product quality (Total Quality Management) and waste streams of a company (Waste management). Such management tools help the management to identify the environmental costs that are hidden in the bookkeeping system (the hidden costs). In many, mostly larger, companies, environment is placed in a broader management perspective. Risk management is increasingly seen as an umbrella for the different functional areas such health and safety, environment and quality. In a large company there may be many unwanted environmental effects. It is most important to know what the risks are, both in terms of incidence and impact. The major risks should be given most attention. The Italiana Petroli case illustrates an environmental risk management context. A cost-benefit analysis based on a broad definition of environmental costs was done in relation to the management of the risks of oil spills from service stations. By so doing, the costs of preventive measures could be weighed against the costs of accidental spills.

Product development can be a most effective means to reduce environmental impacts and the related costs: pollution then is prevented at the 'cradle' (eco-design). One of the drivers of eco-design is producer responsibility for the environmental effects of one's products. This may cause an increasing number of companies to take back their products when the consumers wish to get rid of them. Particularly in the field of office equipment and personal computers, a number of producers already have ample experience in taking their products back in order to reuse and recycle their components as much as is technically and economically possible.

Under these circumstances, recovered and possibly upgraded components have to compete with new components. In principle, the department responsible for making the products may use financial criteria when deciding whether to take a new component or a used (but refurbished) one. To arrive at sound decisions, the internal use of adequate transfer prices is extremely important. A problem may be the final disposal costs of used products which cannot be reused any more. It may be argued that the disposal costs should be part of the cost price of a new product rather than being included in the cost price of a competing used product. By so doing, the competitive position of the used products is improved on a rational basis.

When the reprocessing of discarded products in a central unit has to be reported in financial terms, it may be a problem how to differentiate those costs according to type of product and kind of treatment. In Germany the Eco-Cycle Law requires such calculations. In this case, activity-based costing may be used to produce such figures.

Again ABC may help to provide useful information about costs prices which must be covered by the revenues of a firm on the longer run. Another typical accounting item which is related to the field of increasing environmental performance is external reporting. For reasons of accountability and reputation, external communication about a firm's environmental policy and performance may be very important. Eco-management accounting systems can be major sources for external reporting. If official rules do not prohibit it, the results of eco-management accounting can also be used for reporting to external stakeholders.

Table 3.3.9 provides a road map to the case studies. The table indicates that the four important fields for the application of eco-management accounting are addressed in several case studies. By reading the specific case studies in greater detail, the reader gains insight into the mixture of different management accounting devices which are used to solve present accounting problems. The cases show how the specific firms ask for their own solutions that are largely determined by the processes, culture and structures at hand in a firm. For more insight into the role of a controller (financial manager/accountant) in establishing a bridge between environmental management and management accounting, the following cases are mentioned: AGIP SPA, Cartiera Favini, Italiana Petroli SPA, SGS-Thompson Microelectronics, Baxter BAXTER, IBM, Philips Germany, Sony Germany, Xerox (NL).

Table 3.3.9 A roadmap to the cases

Item:	Frequency:	Case studies:
Activity-based costing (ABC)	11	IBM, Meerssen Papier, Philips, Xerox (NL), Sony, Xerox (UK), Auping.
Product Costing	4	Cartiera Favini, IBM, Philips, Sony, SGS-Thompson Microelectronics (I), XYZ, Zeneca.
Accounting methods	8	Italiana Petroli, Meerssen Papier, Philips, Xerox (NL), Xerox (UK).
Bookkeeping	11	AGIP, Cartiera Favini, IBM, Philips, Xerox (NL), Sony, SGS-Thompson Microelectronics (I)
Budgeting	25	AGIP, Baxter BAXTER, Cartiera Favini, Hercules, Auping, IBM, Italiana Petroli, Meerssen Papier, Philips, Xerox (NL), Sony, SGS-Thompson Microelectronics.
Cost Price	15	IBM, Meerssen Papier, Philips, Xerox (NL).
Eco-design/Product development	7	Baxter BAXTER, Italiana Petroli, XYZ, Philips.
Externalities (external costs)	9	Hercules, XYZ
External Reporting	2	Baxter BAXTER, Philips
Investment Assessment	1	Italiana Petroli
Total Quality Management	4	Baxter BAXTER, Xerox (NL), Xerox (UK), SGS-Thompson Microelectronics.
Waste Management	21	AGIP, Baxter BAXTER, Cartiera Favini, Hercules, Italiana Petroli, Sony, SGS-Thompson Microelectronics.

The second column of Table 3.3.9 refers to the frequency that an accounting/environmental item is mentioned in the total set of case studies. This is also shown for three cost items that are often associated with environmental costs.

Table 3.3.10 The case studies that focus on some specific environmental cost items.

Cost item:	Frequency:	Case studies:
Hidden costs	6	AGIP SPA, Cartiera Favini, SGS Thompson Micro electronics.
Quality costs	13	Cartiera Favini, Hercules, Meerssen Papier, SGS-Thompson Microelectronics, Xerox (UK).
Costs of decommissioning	6	AGIP SPA

The essence of categorising costs according to the principle of quality, lies in the importance of prevention. The ideal is zero defects; this can be reached only by preventive actions. In environmental matters, this principle is translated into zero waste (which, if taken literally, is impossible, but its adoption as an espoused aim may indicate a company which takes environment seriously). The relationship between preventive environmental costs

and costs of failure (such as waste disposal and air purification) signifies the financial side of going for zero waste.

The tracking and calculation of environmental costs based on quality management may be seen as a tool to measure the quality of a firm's environmental management. The greater the preventive environmental costs are, relative to the other environmental costs, the greater the quality of the environmental management. A problem here may be finding an adequate benchmark. Such a benchmark requires another business organisation which is of a comparable size and production process. Moreover, both organisations have to apply the same definitions of environmental costs so that differences in allocation principles will not blur the data which it is wished to compare.

3.5 Some conclusions

The cases are evaluated on the following criteria:
- the management accounting problems addressed in the case studies;
- the eco-management accounting solutions provided.

As a consequence of the close link to environmental management, eco-management accounting often requires a close collaboration between environmental and accounting professionals. The case studies show that there is a trend towards further integration of the information systems used by firms. The information sources developed by environmental management often become part of the overall information system of the general management system. However, there is evidence that full integration may be considered as infeasible because the cost of integration outweighs the benefits. In such a case environmental cost information remains to be generated by separate accounting tools. The management of the firm depends on information that is generated by several management systems. In such cases the bridges between environmental management and the accounting functions may be quite complicated, and require considerable design and linking knowledge which goes beyond a 'simple' interface with existing information systems. Therefore, reducing the cultural gap between the controller (financial manager/accountant) and environmental specialists is an important issue. Consequently, there is a need for adequate educational materials directed at both the environmental managers and controllers. In general, the case materials show that eco-management accounting is still immature. However, it can be expected to emerge as an indispensable tool of environmental management.

4 Summaries of the case studies

Co-edited by Michiel Wind

This chapter contains elaborate summaries of the 15 company-based case studies, which follow a common content. The following companies were involved (some of them wished to be reported anonymously): Philips Deutschland's glass factory; Sony Deutschland; IBM Germany; Favini Cartiera; SGS-Thomson; Italiana Petroli; AGIP; a producer of bed furniture; two sites of a chemical company; Xerox in Venray; Meerssen Papier, Baxter's health care plant in Castlebar, Xerox in the UK, Zeneca's Huddersfield site, an electronics company in the UK.

4.1 Company-based experience in eco-management accounting: three case studies in Germany

4.1.1 Defining environmental costs for the Philips Glass factory in Aachen

Tatjana Becksmann
Jan Jaap Bouma

1 Introduction

This report focuses on the environmental costs of the Philips glass factory at Aachen. However, so far neither literature nor practice offer a generally accepted definition for the term 'environmental costs'. Therefore, as part of this case study, a specific definition for this term is developed. This definition is designed especially for the case study's purposes and for the glass factory and consequently, cannot be applied directly to other purposes or companies.

2 Description of the glass factory

The Philips glass factory at Aachen is a plant where special glass is produced and melted into parts (screens and cones) of televisions' cathode ray tubes. In 1995 the glass factory employed 1000 people and had a turnover of 350 million DM, 300 million DM for glass production and 50 million for the connected glass development research centre, the Applied Technology Glass (ATG).

The Philips Corporation is organised both in national branches and in product divisions. Thus, the glass factory is a subsidiary of the Philips Deutschland GmbH, as well as being part of the product division 'Components' that has its headquarters at Eindhoven (Netherlands). The glass factory shares the site at Aachen with two other Philips plants, the cathode ray tube factory (CRTF) and the light bulb factory (LBF).

In the internal organisation of the glass factory, the main (line) departments as well as the staff departments company medical department, environment, industrial safety and the factory committee are answerable to plant management.

In the place of a mission and strategy the Philips Corporation employs five corporate values. Those are: delight customers, value people as our greatest resource, deliver quality and excellence in all actions, achieve premium return on equity and encourage entrepreneurial behaviour at all levels. Those general values were translated into specific goals for the glass factory. The environment is included in those goals, but is not mentioned directly. Instead, there has been an environmental programme at Philips since the 1970s, which expresses environmental targets.

The glass factory produces two products, television screens and cones. The production processes for those products differ and so does the material mix.

3 The glass factory's environmental challenges

The environmental manager of the glass factory named the following main environmental challenges:

Reduction and recycling of waste.
1. Reducing the use of fresh water.
2. Full implementation and further development of the environmental management system.

The first two of those challenges are connected with environmental costs. A reduction in waste and in the use of fresh water will also lead to lower costs. The recycling of waste not only saves waste disposal costs, but also saves raw materials.

As for the third challenge, it is not planned to include environmental costs and their reduction into the environmental management system. Instead, they are more and more allocated to the departments that cause them. This is done to promote cost-awareness in those departments and it is hoped, that the further allocation of waste costs will lead to decentralised cost reduction projects.

4 Environmental Management system and environmental organisation

The glass factory has installed an environmental management system according to ISO 14000. This management system is documented in an environmental management manual and has just been certified. The release of environmental statements is planned, as well as regular internal and external audits.

The glass factory's environmental policy postulates the consideration of active environmental protection in all business activities. The environmental protection activities are to be future- and prevention-oriented and compliance with legislation is considered to be only the minimum target of those activities. The environmental policy is translated into

several environmental objectives that among others include eco-design of products and processes, continuous improvement, education of employees and suppliers, etc. Continuous improvement among other targets also refers to the named environmental challenges, i.e. reduction in water use and waste production, waste recycling and the full implementation and further development of the environmental management system.

The site at Aachen as a whole has several legally required environmental representatives. Those are the representatives for environmental protection, for water protection, for emissions and their impacts on the environment, and for hazardous substances. The responsibilities of those functions are described in the environmental management system manual. The legal environmental representatives are answerable to the department of environmental co-ordination. This department co-ordinates all environmental activities at the Aachen site as well as all contacts to local authorities, neighbours, media, etc. The head of the department is the environmental co-ordinator.

Other environmental activities are organised in the environmental department. The head of this department is the glass factory's voluntary representative for environmental protection and the department is answerable to the plant management. The environmental co-ordinator and the environmental representatives of all plants at the Aachen site meet once a month in the environmental committee to discuss environmental problems of the site that go beyond plant level.

The glass factory does not employ any material flow accounting methods like Life Cycle Assessments or the German Ökobilanz (eco balance) and it is not planned to do so in the future. Those methods are not used, because the gains that might be achieved by using them are estimated to be lower than the effort needed in introducing them in the glass factory's case. Life Cycle Assessments, however, are done by the Philips Corporation as a whole, for example was one done for a whole television set, including data from the glass factory.

5 The management accounting system

The glass factory has got a fully implemented management accounting system containing the elements bookkeeping, budgeting, capital budgeting, product costing, performance measurement and internal reporting. The management accounting system was judged to be of considerable importance to environmental management both now and in future. Of the management accounting functions the environmental specialist considered the functions bookkeeping, operational budgeting, performance measurement (including process changes and material substitution) and internal reporting as crucial for environmental management. The controller saw considerable importance in the functions bookkeeping, operational budgeting and internal reporting, while he considered product costing and performance measurement as crucial for environmental management.

The controller at the glass factory is responsible for special reports and studies; accounting for current planning and control, including cost records and budgets/performance analysis; general accounting, including accounts payable, accounts receivable, general ledger, billing and partly property accounting; and also partly for internal audits and taxes. When the controller is only partly responsible, additional responsibility lies with the Philips Deutschland GmbH at Hamburg of which the glass factory is a subsidiary.

Management Accounting plays a role in dealing with the glass factory's environmental challenges as far as costs are concerned. This role is not considered to be very important though, since capital budgeting projects in the environmental field usually are justified with different arguments. Those arguments are either compliance with legislation or a feeling of the company's responsibility for the environment. Cost reductions only very rarely are used as a justification for environmental investment proposals. Environmental investments at the glass factory are those investments that completely or predominantly serve the protection of the environment. This excludes all investments necessary for keeping up the production process, while including investments that are mainly justified with environmental protection effects, but that also lead to cost savings.

The cost accounting system of the glass factory first assigns cost items to cost categories. After that, the costs of raw materials are allocated directly to the product. All other costs are first allocated to cost centres. Cost centres are locations in the plant, where costs are incurred, those locations being accounted for as separate units. There are main and auxiliary cost centres at the glass factory. The main cost centres are cost centres, where production takes place, while all other cost centres are auxiliary cost centres. The costs that first are allocated to cost centres, are reallocated to the product later as part of the product costing process.

The glass factory does not use the cost accounting method activity-based costing (ABC) yet, but has already taken the first steps to introduce it in certain areas such as logistics. An introduction is planned for analysing costs and their drivers. A use of ABC for product costing is not planned, since the products are very similar and the differences between them are not considered to be large enough to justify an introduction of ABC in this respect. So far, environmental costs were not considered to be important enough to justify an introduction of ABC for their allocation either. Though the glass factory has not used ABC so far, the production process is resembled in cost accounting. Thus, some costs such as water and energy consumption, are allocated directly to the processes that cause them.

The Life Cycle Costing Method is used by the Philips Corporation, but the concept is not utilised at the Aachen plant.

For product costing a full cost absorption method is used. The products' costs are allocated to them in several steps, following the activities that are needed to produce the products. For each activity the direct activity costs (raw materials and labour) are allo-

cated to the product, which is followed by allocating the overhead costs for the particular production department. Factory overhead costs also are allocated to the product in each production step. The amount of factory overhead costs that the product has to absorb in a production step is calculated by multiplying predetermined percentages of overhead costs by the sum of labour and departmental costs of the production step.

6 *Environmental cost transparency and why it is important for the glass factory*

The glass factory takes measures for environmental protection, which lead to costs. On the other hand also a lack of measures for environmental protection can lead to costs, e.g. to waste disposal costs, if waste is not avoided. Both kinds of mentioned costs are related to the environment and therefore, can be termed environmental costs.

The environmental costs of the glass factory have not yet been identified or defined and often are not obvious, being hidden among other cost items. A need is felt to make those costs transparent. There are several reasons for wanting more information on environmental costs. First, there is a feeling that environmental costs are rising and the wish to control and reduce them. Secondly, the management wants to protect the environment. However, decisions in favour of environmental protection measures are considered to be easier, if all the costs and financial benefits of those measures are known. A third reason for making environmental costs transparent, is external reporting. Environmental cost data can not only be used to create a positive image of the company with its stakeholders, they are also demanded by the German federal statistical administration (Statistisches Bundesamt) according to the German Umweltstatistikgesetz (law concerning environmental statistics). This law demands of 15,000 representatively chosen German companies to deliver data on their expenditures for investments, that completely or predominantly serve environmental protection and on operating expenses for measures, that completely serve environmental protection purposes.

So far environmental costs were not an issue at the glass factory. They were only considered, when compliance investment projects were done, in order to find the most economic investment alternative. The glass factory at the moment is in the process of introducing the SAPR3-Accounting software in which environmental costs are not considered either. Nevertheless, a more important role of environmental costs in the future is recognised both for the costs of prevention and for the costs of remediation of pollution. Therefore, the administration of the glass factory regards the ECOMAC case study as a means to make their environmental costs transparent and to give indications as to possible changes in accounting for them, in order to make them better controllable and easier available for decision-making. Decision-making here mainly refers to decisions about environmental protection measures and measures of cost control. For environmental protection measures not only the decision, whether to introduce them or not, is important, but also the decision, which alternative investment should be chosen. The use of knowledge on environmental costs for product costing decisions was considered to be lower, since there are

only two products and only few varieties of them. Those products and product varieties were not supposed to be very different in the environmental costs they cause.

The goal of this case study is to identify the environmental costs of the Philips glass factory and to make suggestions for improving the glass factory's cost accounting system in a way that environmental costs are made transparent. Cost transparency is vital for effective cost control and the use of environmental cost information in decision-making. Transparency of environmental costs includes two aspects. Costs have to be identified as environmental and they have to be allocated to processes and products in a way that reflects the part, those products and processes take in causing the environmental costs. If the causes for environmental costs are unknown or worse, are determined wrongly, then decisions based on that information will have an unsatisfactory outcome. Therefore, in this case study environmental costs will not only be identified, their allocation to processes and products will also be judged from the viewpoint of environmental cost transparency.

7 *Environmental costs at the glass factory*

To identify environmental costs in a company's cost accounting system, first, it is necessary to define the term 'environmental costs'. Since literature does not provide a generally accepted definition, one has to be constructed. In choosing a definition for environmental costs, the specific situation in the company as well as its motivation for addressing the topic of environmental costs should be taken into account. Thus, the chosen definition is company specific and cannot be applied directly to other companies.

For the Philips glass factory the following definition of environmental costs was chosen.

'*The operational environmental costs of an organisation equal the monetary value of goods and services sacrificed for environmental protection measures as well as for the absence of such measures. The operational environmental costs are net costs, therefore any monetary gains achieved through measures for environmental protection have to be subtracted.*'

This definition is similar to the one of Kirchgäßner (Kirchgäßner, 1995, p. 130).

The definition is based on the following assumptions:

1. Investments into fixed assets are considered to be environmental protection measures if they are completely or mainly justified with environmental considerations. This also includes equipment that was justified with environmental protection effects, but at the same time leads to substantial cost savings (e.g. the glass factory's water recovery plants).
2. If a fixed asset is considered to be an environmental protection measure, all costs incurred to render the asset operational have to be considered as environmental costs. The costs should be considered as depreciation as far as the expenditures can be activated. For expenses, that cannot be activated, another way of considering them has to be found.

3. All operating costs incurred in the operation of environmental protection equipment are considered to be environmental costs.
4. The costs caused by the absence of environmental protection measures also encompass all wastewater and waste costs.
5. Fragments of products that do not meet quality standards are not considered to be waste Instead, they are production input, since they are needed to ensure a homogenous distribution of the different raw materials in the melting process. Consequently, costs related to those glass fragments are not considered to be environmental costs.

At present, some environmental costs are easily identifiable in the glass factory's cost accounting system. This is the case when a cost category only contains environmental costs (e.g. cost category 6696, Waste Disposal). In other cases environmental costs are hidden in more general cost categories (e.g. all costs related to wastewater treatment are part of cost category 6273, Energy: Water).

As the possibilities of identifying them, also the allocation practices for environmental costs in the glass factory's cost accounting system are not uniform. Some environmental cost items are allocated to the processes that cause them. This is sometimes done as part of an identifiable environmental cost category, but mostly those costs are hidden in general cost categories. Other cost items are pooled in special environmental cost centres, which are treated as overhead costs and later reallocated to the products. In other cases environmental cost items are both hidden in general cost categories and allocated neither to processes nor to environmental cost centres (e.g. environmental damages insurance).

The case study presents the identified environmental cost items and their assignment to cost categories as well as the allocation of those cost categories to cost centres.

8 Interpretation of the findings

8.1 Evaluation of the found situation

In this research the transparency of environmental costs has to be evaluated. Environmental cost transparency has two aspects, the identification of environmental costs and their correct allocation to the products and processes that caused them. Ideally, the two go together by not only indicating environmental cost items as such, but also by allocating them correctly to products and processes. However, to achieve this ideal state of environmental cost transparency, a more complicated cost accounting system than the glass factory's would be necessary. Here, the benefits from making environmental costs transparent, such as the possibility of better cost control, should be weighed against the costs for adapting the cost accounting system. Therefore, not absolute transparency but an optimum of environmental cost transparency should be set as a goal. This optimum should also take the efforts needed for changing the cost accounting system into account.

At the glass factory environmental costs are only rarely easily identifiable as such, by being part of a purely environmental cost category. In those cases, cost transparency is achieved by allocating the costs correctly. This is the case for those parts of cost category 6696, Waste Disposal, that are allocated to cost centres other than 2150, Buildings. Cost category 6271, Energy: Heat Exchanger also is purely environmental, but it has to be identified as environmental revenues first, which the name does not suggest. This cost category is allocated correctly to the cost centres 2410, 2610, and 2710, where the revenues are caused.

Some cost items, though they are part of general cost categories, can still be identified as environmental, because they are allocated to environmental cost centres. By allocating them to those cost centres, however, they are not always allocated correctly. This for example is the case for the costs of environmental services rendered by the cathode ray tube factory (cost category 6677), which all are allocated to cost centre 1075, Environmental Protection. The costs for the water recovery plants, which are allocated to cost centre 2200, Water Recovery also are identifiable and their first allocation is correct. The reallocation in product pricing, however, is not correct. On the one hand two thirds of those costs is assigned to glass production, although all of them are caused by the finishing process. On the other hand the costs of the screen and cone water recovery are pooled in one cost centre and allocated to screens and cones in proportion to the finishing costs of each product. This may or may not reflect the true part, the products take in causing those costs.

In other cases cost items are allocated correctly to the cost centres where they were caused, but they cannot be identified as environmental, because they are assigned to general cost categories such as depreciation (6200, Depreciation on Fixed Assets). This for example is the case for the depreciation of the denitrification filters at the furnaces B and D. Other cost items can neither be identified as environmental nor are they allocated correctly. This for example is the case for the costs incurred for cleaning the sewer system that are supposed to be part of cost category 6697, Services LBF/General Assistance, which is allocated to cost centre 2170, Technical Assistance.

To summarise the situation, it can be said, that although in the glass factory's cost accounting system some costs are readily identifiable as environmental costs and several environmental cost items are allocated correctly to processes and products, some efforts still are necessary to make environmental cost transparency possible. To determine the extent of those efforts as well as the extent of the targeted cost transparency, the expected gains should be weighed against the costs of changing the cost accounting system.

If the cost accounting system and the cost allocation practice are not changed, cost transparency can still be improved by formulating rules of how many percent of the costs in a cost category or cost centre are incurred for environmental protection. It would also be helpful to identify environmental components of general cost categories on a lower level,

e.g. to separate the environmental protection equipment from all other equipment in generating the data for cost category 6200, Depreciation on Fixed Assets.

8.2 Suggestions for the improvement of environmental cost transparency

1) Making environmental cost categories easily identifiable by their names

When cost categories only contain environmental costs, they could be recognised faster as such, if their name reflected this fact. So far, the only purely environmental cost categories are 6696, Waste Disposal and 6271, Energy: Heat Exchanger. Especially the second of those is not readily identifiable as environmental and the name does give no hint, that this category does not include costs, but revenues. Apart from labelling environmental cost categories in their names, cost categories that are not environmental should not be named in a way that makes them appear so. This, however, is the case for cost category 6236, Waste Disposal (Environment), Surface Cleaning. This cost category, though its name includes the words 'waste disposal' and 'environment', contains the costs for cleaning surfaces. Those costs are incurred to avoid a disruption in the production process and not for environmental purposes.

2) Separation of environmental cost items in general cost categories

Most environmental cost items are not part of a purely environmental cost category, but of general cost categories, which also include non-environmental costs. Here, to promote transparency, the environmental costs should be separated from the non-environmental ones. A possibility for doing so is the creation of new cost categories for the environmental costs, but this might make the cost accounting system too complicated. Another option is the separation of environmental costs on a lower level, i.e. ordering the costs in a cost category into environmental and non-environmental. Thus, environmental cost items can be identified, which facilitates their correct allocation to products and processes. In this respect, all environmental cost items should be recorded separately. This at the moment is not the case for the depreciation of some environmental protection equipment like the filter at day bunker B or the monitoring equipment, since the expenditures for this equipment were not activated separately. The costs for auxiliary materials also should be recorded separately. This is important both to control the costs of auxiliary materials needed for environmental protection equipment and to determine the costs or gains of material substitutions done for environmental reasons.

Another option for highlighting environmental costs is to determine percentages, as to how much of the costs in a cost category or cost centre is environmental. This, however, not only has the disadvantage of being an estimate, the environmental cost items also cannot be identified and therefore, not be allocated correctly. Still, formulating percentages might be advisable for cost categories or cost centres where the environmental cost parts are difficult to determine. This for example is the case for all cost categories containing labour

and additional labour costs. Here, a percentage for each labour cost category and each cost centre, to which this cost category is allocated, should be found.

3) Transparency of costs for environmental services rendered by the other two plants at the site

The costs for all services rendered by the other two plants at the site are summarised in the two cost categories 6677, Partial Costs CRTF (cathode ray tube factory) and 6697, Services LBF/General Assistance (light bulb factory). Those cost categories contain environmental and non-environmental cost items. To improve the transparency of environmental costs, it would be advisable to split the two cost categories into four by separating environmental from non-environmental costs. If this cannot be done, the different cost items included in those categories at least should be labelled as environmental and non-environmental. The environmental cost items also, as far as possible, should be allocated to the processes that caused them.

Cost category 6677, Partial Costs CRTF contains both the costs for environmental services of the cathode ray tube factory and the costs for training apprentices there. Environmental costs in this category are the costs for handling auxiliary materials, including all administration costs for hazardous substances among those materials and the costs for feeding input into some filters. The environmental costs also include waste handling costs and the costs for a person separating scrap glass of the cathode ray tube factory into screen glass and cone glass for recycling at the glass factory. So far all environmental costs from cost category 6677 were allocated to cost centre 1075, Environmental Protection. Instead, the costs for handling auxiliary materials, for doing the hazardous substances administration, and for feeding the filters could better be allocated to the furnaces where the filters are situated and the auxiliary materials are used and therefore, the costs are caused. The waste handling costs from this category should be allocated together with the waste costs of category 6696, Waste Disposal, if a relation between the two cost categories can be found. Thus, the different departments would become aware of all the costs they cause in producing waste.

Cost category 6697, Services LBF/General Assistance apart from non-environmental cost items contains all costs of the legal environmental representatives and the environmental co-ordination for the site. It is also supposed to contain costs for services like the cleaning of the sewer system. So far all the environmental costs from this category were allocated to cost centre 2170, Technical Assistance. Instead, the costs for the legal environmental representatives and environmental co-ordination should be allocated to cost centre 1075, Environmental Protection. This cost centre then would include most of the costs for environmental administration, that the glass factory incurs. Cost items like the sewer system cleaning should be reallocated as well, if possible. Here an allocation to the water recovery plant would be advantageous, not only because all costs of this cost centre are environmental, but also because the plant causes those costs by not being able to remove all mud from the released water.

4) Correct allocation of environmental costs to cost centres

Most costs connected with environmental protection equipment are already allocated to the cost centres, where this equipment is located. Those can either be general cost centres or environmental cost centres like 2200, Water Recovery. However, environmental costs also include all waste costs from cost category 6696, Waste Disposal and waste handling costs from category 6677, Partial Costs CRTF. Some of the waste costs from category 6696 are allocated correctly to the costs centres, where they are incurred. Other waste costs are allocated to cost centre 2150, Buildings, which does not reflect the way they were incurred. A further allocation should be considered, since this would make people in the respective costs centres aware of the costs they are causing and might make them start projects for cost reduction. The environmental manager stated, that a further allocation of waste costs from category 6696 was planned.

All waste handling costs from category 6677 so far are allocated to cost centre 1075, Environment. As suggested in 3), they instead should be allocated together with the waste disposal costs from category 6696 to those cost centres that produce waste and therefore, cause waste costs.

5) Concentration of connected environmental costs in environmental cost centres

As said before, costs should be allocated to costs centres, where they are caused. This, however, is not possible for some environmental costs, such as the costs of environmental administration. Here, nobody can determine, which part of the environmental administration costs is caused by each production step. Therefore, it is sensible to create some purely environmental cost categories for such costs, thus making them easily identifiable. To make environmental costs transparent, all costs related to the purpose of an environmental cost centre should be concentrated there. The glass factory has two purely environmental cost centres, i.e. the cost centres 1075, Environmental Protection and 2200, Water Recovery. Of those, 1075 should include all costs for environmental administration and 2200 all costs connected to the two water recovery plants.

So far cost centre 1075 only includes the costs for the voluntary environmental representative, while the costs for environmental co-ordination and the legal environmental representatives as part of cost category 6697, Services LBF/General Assistance are allocated to cost centre 2170, Technical Assistance. The latter costs also are incurred for environmental administration and should be allocated to cost centre 1075, as already mentioned in 3). Other cost items like the costs for office materials, postage, telephone, fax, computer leasing and software are part of the general cost categories 6640, Office and Drawing Materials, 6340, Postage/Telephone/Fax, 6225, Computer Leasing, and 6337, Software and Data Communication, which are allocated to cost centre 1068, Miscellaneous Items (Office). Although those costs were considered to be too low to justify a change in their allocation practice, this should be checked. If the costs are not reallocated, the cost

data should at least be generated in a way that makes the identification of the cost parts caused for environmental administration possible, as suggested in 2).

Cost centre 2200 contains costs connected with the two water recovery plants that clean the water from the finishing processes of screens and cones. However, so far not all the costs connected to water recovery are pooled there. The costs for maintenance and repairs of the plants themselves, as well as the costs for maintaining and calibrating connected monitoring equipment, are allocated to cost centre 2170, Technical Assistance. It was estimated, that the costs in this cost centre contain about 50% of costs connected to the water recovery plants. If possible, those costs instead should be allocated to cost centre 2200. If this is not feasible, they at least should be considered in product costing. This could be done by increasing the percentage of costs from cost centre 2170, that are allocated to the finishing process. As already mentioned in 3), the costs for cleaning the glass factory's sewer system should also be allocated to cost centre 2200, instead of allocating them to cost centre 2170, Technical Assistance.

6) Correct allocation of environmental costs in product costing

Environmental costs should be allocated to the products that caused them, because otherwise the cost-price of those products does not reflect their true costs and based on this cost-price wrong decisions are made. Still, there are different kinds of environmental costs. While for some environmental costs it can be determined, for which process and product they were incurred, for others, this is almost impossible. An example for the latter category are the costs for environmental administration, which is done for both screens and cones without any possibility of determining the extent of administration done for each product. Other costs, like the costs for water recovery, can be traced to a specific step in the production process and it can be determined for which product they were incurred.

Most of the costs related to environmental protection equipment are allocated to main cost centres already, which represent single steps in the production process. This ensures, that in product costing those costs both are allocated to the production step, as well as to the right product. This, however, is not the case for the costs of the two water recovery plants, that belong to the finishing process of screens and cones. So far, those costs in product costing were allocated to glass production by two thirds and to finishing by one third. Since the water recovery serves for processing used water from the polishing and grinding of the products, it serves the finishing department only. Consequently, its costs should only be allocated to the finishing process. The allocation to the products (screens and cones) also does not reflect the way the water recovery costs were incurred. Although the costs of the two water recovery plants for screens and cones are pooled in one cost centre, they are not the same. On the one hand does the screen production need more grinding and polishing and therefore, more water needs to be recovered there and more mud has to be disposed of. On the other hand does the mud from the cone production contain lead, thus being potentially more expensive to dispose of. The differences in

costs should be determined and then included into the pricing of screens and cones. Otherwise, the cost prices for the two products do not reflect their true costs.

9 Conclusions and broader relevance of environmental cost transparency

This research aimed at making the environmental costs of the Philips glass factory at Aachen transparent. For doing so, the term 'environmental costs' first had to be defined. Since there is no generally accepted definition for environmental costs yet, a specific definition was formultated. This definition is based on the glass factory's situation and on the purposes of this case-study and consequently, cannot be taken over directly for other purposes or companies.

The transparency of environmental costs at the glass factory was judged along two criteria, the identification and the allocation of environmental cost items. Environmental costs were assumed to be transparent, when all environmental cost items are easily identifiable as such and at the same time are allocated to products and processes in a way that reflects their part in causing those costs. Although at the glass factory some environmental cost items are easily identifiable and several are allocated correctly to processes and product, some efforts are still needed to make environmental cost transparency possible. This report gives some suggestions for changes in the cost accounting system, in order to improve environmental cost transparency at the glass factory.

In general, the environmental performance of companies becomes more and more important and their environmental costs as the costs of environmental protection are rising. This is not only due to stricter government regulation, but also to an increasing environmental awareness of customers and other stakeholders. At the same time many businesses change their attitude from reacting to government laws and regulations towards a more proactive approach, where the environment is not seen as a cost driver any more, but as a business opportunity. Reactive or proactive, all companies should be interested in controlling their environmental costs, and therefore, should have an interest in making those costs transparent.

The Philips glass factory at Aachen is not the only Philips plant interested in a better understanding of its environmental costs. Also a plant at Oss (Netherlands), that is part of the Philips Lighting division, has started a project to define and identify environmental costs. The definition and analysis of environmental costs is very plant-specific, since different plants have different environmental problems and thus, different environmental costs. Still, a comparison between the two projects should be made and common results should be identified. This might be a first step for defining environmental costs corporate-wide and for giving all Philips plants the knowledge and means necessary to plan and control them.

As the Philips glass factory also other German companies are interested in environmental cost transparency and environmental cost accounting. This among other factors is pro-

moted by the German Umweltstatistikgesetz (law concerning environmental statistics), that forces companies to deliver data on their environmental expenditures and their ongoing environmental expenses to the federal statistical administration. The companies affected by this law are interested in ways of gathering the demanded data and also in alternative uses, those data might have.

From a global perspective, companies' markets become more competitive with the increasing globalisation. To be able to keep their position in the markets, companies have to control costs as far as possible. Therefore, making environmental costs transparent and thus controllable in future might become a competitive advantage.

Abbreviations

ABC:	activity-based costing
AM:	auxiliary materials
ATG:	Applied Technology Glass
CRTF:	cathode ray tube factory
ECOMAC:	eco-management accounting
e.g.:	for example
GA:	general assistance
GmbH:	Gesellschaft mit beschränkter Haftung
i.e.:	that is
ISO:	International Standard Organisation
LBF:	light bulb factory

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4.1.2 Defining environmental costs for Sony Deutschland

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1 Introduction

This case study focuses on the environmental costs of Sony Germany. However, so far neither literature nor practice offer a generally accepted definition for the term 'environmental costs'. Therefore, in this case study two specific definitions for the term are developed, one for each of the case study's two parts. The first part deals with the environmental costs of Sony Germany as the costs of environmental management. The environmental costs are further subdivided into the costs of environmental management in general and the costs of the environmental management system in particular. The second part of the case study deals with the costs to which the prospective Electronic Waste Directive might lead.

2 Description of Sony Germany

The Sony Deutschland GmbH (subsequently referred to as Sony Germany) is a distribution and service organisation. It is part of the Sony Corporation, which has its headquarters at Tokyo (Japan). Sony Germany employed 1700 people in 1996 and had a turnover of 3.8 billion DM in 1995/1996. The Sony Germany headquarters are at Cologne, but there are subsidiaries for service at Stuttgart, Berlin, Hamburg, Frankfurt and Munich.

The distribution part of Sony Germany is divided into several product divisions. First, a separation is made between broadcast & professional products (BPG) and consumer products. The consumer products are further subdivided into the divisions CAV (Consumer Audio/Video), RM (Recording Media), ME (Mobile Electronics, producing tapes, headphones, etc.), IPG (Information Product Group, producing mobile telephones) and ITG (Information Technology Group). The service part similar to the logistics part is divided into Consumer Service and Broadcast and Professional Service.

The departments Consumer Service Repairs, Consumer Service Support, Logistics, Systems and Administration are part of the line Support Service Functions. The Environment, Safety and Quality department has some line functions as part of the Administration department. Those line functions comprise waste management, the environmental management system, working safety and quality management. The same department also has consulting staff functions, which are independent of the Administration department and instead, are a Support Service Function of their own.

Environmental protection is not part of Sony's mission and strategy. It is, however, recognised as an important company goal.

3 Sony Germany's environmental challenges

The environmental co-ordinator of Sony Germany identified the following environmental challenges for her company:

1. To make the environmental management system transparent to all employees, while also making its costs and benefits transparent.
2. To save energy in the management of buildings and workshops.
3. To bring the environmental sector close to Sony customers as a service.

All three environmental challenges are connected to environmental costs. The first challenge aims at making the costs and benefits of the environmental management system transparent. The second challenge is connected to environmental costs in a way that the saving of energy also leads to cost savings. As for the third challenge, before giving services to Sony customers, the price of those services has to be determined. For determining the price of the offered services, the related costs have to be identified and taken into account.

4 Sony Germany's environmental management system

Sony Germany has implemented an environmental management system that is certified against the ISO 14001 standard. Yearly audits for the system are planned. However, the environmental management system so far only applies to the consumer service department at Cologne. For the other parts of Sony Germany an introduction and certification is planned in the following order:

- Consumer service centres at other locations,
- Broadcast and Professional Group (BPG) service,
- facility management at the Cologne site,
- logistics department.

After setting them up, it is planned to merge all those environmental management systems into one.

Apart from the environmental management system, the department of environment, safety and quality also maintains a waste management system, a quality management system according to ISO 9000 and a working safety system. The quality management system so far has only been introduced in the Broadcast and Professional Service. Similar to the environmental management system an introduction of the quality management system also is planned for all other sectors. Further on, an integration of the environmental and the quality management system is intended. The department of environment, safety and quality employs a student who is writing his master thesis on this integration problem at the moment.

For maintaining the quality management system and its certification, the certified department pays an annual fee to the department of environment, safety and quality. A similar fee is planned for the maintenance of the environmental management system.

Sony Germany employs a voluntary environmental representative who also takes over the responsibilities of the legal environmental representative for wastes. Other legal representatives, e.g. for emissions to air or water are not needed, since Sony Germany is not a producing company and therefore, does not have emission problems. The legal representative for working safety, an outside consultant who is attached to the department, as part of his responsibilities also is concerned with the administration needed for hazardous substances.

Sony Germany has not released an environmental statement or report yet and none are planned for the future. Environmental management information is given to the public in the form of press releases and press maps. An environmental image brochure is planned.

Sony Europe operates an environmental centre at Fellbach (Germany), which is financed by the national branches. The Environmental Centre Europe (ECE) consults the national Sony companies in introducing environmental management systems and also conducts special projects. The costs for those projects usually are paid by the party initiating the project and not by the national European organisations.

Sony Germany so far has done no Life Cycle Assessments or Eco-Balances and does not plan to use those methods in the future. However, Life Cycle Assessments were done by Sony Europe.

5 Sony Germany's management accounting system

Sony Germany has a management accounting system that includes the functions bookkeeping, budgeting, capital budgeting, product costing and performance measurement. Of those functions the environmental manager saw considerable importance for environmental management in budgeting and crucial importance in product costing and monetary performance measurement. She did not consider capital budgeting very important, since there are no capital budgeting decisions of great financial importance made at Sony Germany, because it is not a producing company. The only respect in which capital budgeting might be important for environmental management are decisions on energy saving measures.

The controller saw a considerable importance for environmental management in bookkeeping and budgeting, while he considered capital budgeting, product costing and performance measurement to be crucial for environmental management. Although he rated capital budgeting as crucial, he admitted that it did not play an important role in the company, since Sony Germany distributes goods and does not produce them. As for product costing, environmental issues are not included here, but there already have been considerations to do so.

Sony Germany's management accounting department does special reports and studies and it performs the task of accounting for current planning and control, including cost records, budgeting and performance analysis. There is a separate accounting department,

which is responsible for the general ledger, property accounting and accounts payable. The accounting functions are performed using the SAP R2 software. This software is a management information instrument that apart from a cost accounting module also includes other modules, e.g. accounts payable. The company functions accounts receivable and billing are performed by the distribution department. The payroll function, although it is managed by using the accounting software SAP R2, is not managed by the accounting department, but by the personnel department. There are separate departments for internal audits, taxes and electronic data processing. In the future, the electronic data processing of Sony Europe will be pooled in three locations. It is not sure, whether one of those data processing centres will be at Cologne.

Environmental costs are already considered in the controlling and bookkeeping system of Sony Germany and are also part of the profit and loss statement. The term 'environmental costs' in this context summarises four different kinds of costs. Two of those cost items refer to packaging disposal, including product packaging and transport packaging materials. The other two cost items refer to the disposal of used batteries and of scrap electronic products. Those costs subsequently will be named 'classical environmental costs'. There is no one person or department responsible for the control of the classical environmental costs. Part of the responsibility lies with the environmental department, part lies with the product divisions.

The classical environmental costs include two cost items related to packaging disposal. Sony Germany has to pay fees to the Dual System Germany for the disposal of product packaging. The Dual System Germany was founded by German companies as an answer of producers to the German Packaging Ordinance. This ordinance forces producers to recover the packaging of their products and to recycle it. All producing members of the system have to pay fees for the disposal of their products' packaging, which allows them to print a special sign ('grüner Punkt') onto their products. This sign indicates to consumers that they should dispose of packaging materials using the disposal system of the Dual System. The disposal of transport packaging also is a responsibility of producers and distributors according to the Packaging Ordinance. There is a different system in place here, the VFW system.

The classical environmental costs are allocated to the divisions or departments for which they were caused. All concerned divisions and departments have special cost centres for receiving those costs. Packaging disposal costs are allocated to the division which sold the connected products. Disposal costs for waste batteries and electronic scrap are allocated to departments, where the waste batteries and the waste electronic products occur. The latter mainly can be found at the two service departments and the service subsidiaries.

In product costing for the sales products classical environmental costs are not included. An inclusion of the packaging disposal costs into the product price was planned, but did not take place. The plan was rejected, because the product price only considers the pur-

chase price of the goods and revenue decreases due to the sales process, such as special trade discounts. The costs for packaging disposal are no such revenue deductions and therefore, should not be included in the product price. However, as a result of the project, the classical environmental costs now are included in DB II, instead of formerly being part of DB IV. A problem for the further use of Dual System fee data for controlling purposes lies in interface problems between the Dual System Germany software and the management accounting software. This makes the calculation of the Dual System fee for single products impossible. Instead, only the fees for single models and divisions can be calculated. The data for subdivisions (Hifi, Audio, Video) also are not available.

The above used abbreviation DB (gross profit) originates in direct costing. There, only variable or direct costs are considered as product costs. The sales price minus the product costs leads to the gross profit (German: Deckungsbeitrag/DB), which is supposed to meet the fixed costs of the organisation. At Sony the cost accounting system is not a variable one, but a full cost absorption costing system. However, there is a hierarchy of profit (DB) figures for controlling and especially for reporting purposes. DB I gives the gross profit of Sony Germany, i.e. the revenues minus the price Sony Germany paid for the products and minus trade discounts and related deductions in the revenues. DB II equals the gross profit minus advertising, promotion and logistics expenses that are directly related to the customers. In this figure also the classical environmental costs are included. DB III subtracts divisional advertising, promotion, logistics, general and administration expenses from DB II. For calculating DB IV or the net profit, all other advertising, promotion, general and administration costs are subtracted from DB III.

Activity-based costing is not used at Sony Germany, nor is its introduction planned in any respect. Instead, overhead costs like the costs of the support service functions are allocated to the different product divisions by using fixed relations. Thus, 70% of the costs incurred for the department of environment, safety and quality are distributed to the divisions according to their turnover, while 30% of the costs are distributed according to the divisions' headcount.

It was already mentioned that the management accounting system and the accounting system of Sony Germany are separated. This influences the aggregation of cost data. While the accounting system is based on cost categories, those in the management accounting systems are condensed into budget positions. Thus, budget positions may include more than one cost category. The cost categories in one budget position are supposed to serve similar purposes. However, this might make cost data less easily available for other purposes. Thus, the costs for waste and wastewater disposal are part of the budget position 'Care for Ground and Buildings'. If as another purpose, all waste disposal costs should be determined, this budget position cannot be used, since it also includes costs like the maintenance costs for buildings.

For controlling purposes the budget positions are further condensed in several steps. Again the condensing serves to accumulate related costs. The above mentioned problems, therefore, also occur.

6 *The specific problem of this case study and why it is important*

This case study addresses two specific problems that Sony Germany faces. The first problem refers to the costs and benefits of environmental management, on which a need for more information is felt. A need is also felt to make certain environmental costs transparent, such as the costs for the Dual System Germany. The second problem the case study addresses is connected with German waste legislation. It is probable that producers of electronic products may be forced in future to recover those products after use and to recycle them as far as possible. If such legislation should come into force, Sony would be affected by it. Therefore, the company is interested to know more about the costs of such a recovery and recycling duty. In both respects it will be explored, to what extent the management accounting system can contribute to deliver the necessary cost information.

The costs and benefits of environmental management

There are several reasons for wanting to know more about the costs and financial benefits of environmental management. The first reason is creating cost and benefit transparency in order to make a comparison between the two possible. Thus, the contribution of the environmental department to the company's success can be demonstrated.

Another reason is the idea of determining the value of activities that the environmental department performs for other departments. Such knowledge would create a base for charging those activities to the departments for which they were performed. The activities in question mainly refer to assistance that the environmental department gives in the data collection for the Dual System Germany.

A third reason for exploring the costs of environmental management consists in the plan to offer environmental services to Sony customers. This especially refers to seminars concerning the ISO 14000 standard and its application and certification. For calculating the prices for such seminars, the knowledge of the environmental management costs is needed as a base. Generally, it is considered important to make environment-related costs transparent. This transparency is needed to be able to influence and reduce those costs. In this respect, the department of environment, safety and quality is especially interested in making the costs for packaging disposal transparent and to assign them to individual products. This would not only make the revenue situation of the different products more transparent, it is also considered to be a base for product packaging decisions in order to lower those costs. However, while Sony Germany has to pay the fees for packaging disposal, the company not always has influence on the choice of packaging, especially concerning the product packaging. Here, influencing packaging decisions becomes more difficult for products produced outside Germany and particularly outside

Europe, where there are different waste laws and the importance of the German Packaging Ordinance might not be recognised. On the other hand, Germany is the largest market in Europe. Therefore, the department of environment, safety and quality in the future would like to increase their influence on packaging decisions to lower the disposal fees.

Prospective costs of the Electronic Waste Directive

In Germany a new waste law, the Closed Loop Economic Act and Waste Law came into force in 1996. This law aims at encouraging both waste recovery and natural resources conservation and at securing an environmentally sustainable waste disposal and recycling. It establishes a fundamental product responsibility of manufacturers and distributors over the whole life cycle of products. This product responsibility encompasses eco-design of products, labelling of products containing toxic substances, an obligation for manufacturers to recover their products after use by the consumers and an obligation to maintain documentation in this respect (VDMA, 1996, p. 1).

The Closed Loop Economic Act and Waste Law empowers the German government to issue legally binding regulations and ordinances to establish the manufacturers' and distributors' product responsibility (VDMA, 1996, p. 1). An ordinance after this fashion has been discussed for some time, concerning the recovery and recycling of electronic products. This prospective ordinance is commonly called the Electronic Waste Directive. Producers and distributors of electronic products do not want to be caught by surprise in this respect. Therefore, they follow the discussion on possible conditions of the ordinance with interest. Those conditions refer to the way of gathering the scrap products, the sorting of products of different manufacturers, the recycling process, the payment for recovery and recycling and the connected administration. To be able to judge the outcome of ordinances with different conditions and to take preparations accordingly, the costs and benefits of different scenarios have to be determined.

Sony Germany already offers the service of taking back and recycling old computer monitors at a fee of 29 DM. All new computer monitors have a stamp on them that enables the owner to return them for recycling free of charge. The recycling is done by a contractor, the Rethmann company. The recovery and recycling of the computer monitors is a voluntary service of Sony Germany. So far, no similar services for other products are planned, since the conditions of the prospective Electronic Waste Directive are still uncertain.

This case study is targeted at providing a framework for calculating the costs for the recovery and recycling costs of electronic products under different conditions. The cost data calculated by using the framework can be used for two purposes. First, they enable the environmental department to give recommendations for preparations against the effects of the future Electronic Waste Directive. Secondly, they might be used to justify a transfer of recovery and recycling costs to the producing Sony companies. Electronic products are manufactured all over the world, while the recovery and recycling duty will only be intro-

duced in Germany. If they are not charged with the recovery and recycling costs, the producers in other countries will see no need to change the design of their products to make recycling easier and cheaper. At the German production site for televisions research and development has already led to the production of a recycling friendly television line, which as a side effect also leads to lower costs through material savings.

7 *Sony's environmental costs*

As mentioned in paragraph 5, the case study has two goals. This chapter deals with the first of those goals, the identification of the costs of environmental management. The second goal, the calculation of the recovery and recycling costs for used products according to the prospective Electronic Waste Directive, is pursued in paragraph 7.

Determining the environmental costs

To determine the environmental costs of Sony Germany, it first is necessary to define those costs. Although Sony Germany is especially interested in the costs for environmental management, also the costs for energy consumption, waste disposal and the already recognised environmental costs are considered important. Therefore, it was decided to use a definition not only of the term 'costs of environmental management', but of 'environmental costs'. Here, a broad definition was chosen that can also be applied in other respects and at other Sony companies. This broad definition then is applied to the specific case of Sony Germany.

The chosen definition of the term 'environmental costs' is the following:

'The environmental costs of an organisation equal the monetary value of goods and services sacrificed for measures of environmental management as well as for the lack of such measures (polluting activities). The environmental costs are net costs, therefore, any monetary gains achieved by measures of environmental management have to be subtracted.'

This definition is similar to a definition developed by the German ministry of Environment and the German federal environmental administration (BUM/UBA, 1997, p. 43).

In the case of Sony Germany, the above broad definition contains the following elements:

1. Measures of environmental management are measures that are fully or predominantly justified with environmental protection. Those measures lead to investments or the introduction of management systems.
2. Operating costs of environmental protection equipment and management systems are also considered to be environmental costs. In the case of management systems the documentation and keeping up of the systems as well as the necessary personnel and other operating costs are included.
3. The costs caused by the absence of environmental management measures include energy and water costs, as well as all costs connected to waste and wastewater. If

taxes and other fees on emissions should be introduced in the future, those will be included as well.

4. Environmental costs only refer to the different sites of Sony Germany. For the logistics department all costs that are connected to transport activities outside the sites will be excluded.

As already mentioned above, the term 'environmental costs' already occurs in the cost accounting system of Sony Germany. Those classical environmental costs encompass the costs for the disposal of transport packaging and product packaging as well as for the disposal of electronic scrap and old batteries. The named costs are part of the environmental costs as they were defined in this case study, but do by far not account for all of them.

The obvious costs of environmental management occur for personnel, space, computers and other items connected with the department of environment, safety and quality. Here, it should be noted that, since this department also has quality and safety responsibilities, not all costs connected with it are environmental costs. However, in some cases the costs overlap, e.g. do the costs of the legally required safety co-ordinator encompass costs for hazardous substances administration. Those costs also have an environmental aspect.

Concerning the environmental costs, a distinction can be made between the costs of the environmental management system and the general environmental costs, the former being part of the latter. This distinction makes sense, if seminars on the environmental management system and education of third parties are planned and the prices for those activities have to be determined. In this report first the general environmental costs are listed. The specific costs of the environmental management system are listed separately afterwards.

In viewing the environmental costs, it should be noted that there are some limitations. Those result from the fact that Sony Germany does not produce products, but instead distributes them and provides service. Thus, all environmental costs connected to the product itself cannot or can only partly be influenced by Sony Germany. This in particular refers to the costs connected to packaging and to the recycling of scrap products. Both the products' packaging and design are determined by the product management of the respective product lines. Concerning product packaging, this leads to the situation that Sony Germany has to pay the fees for the disposal by the Dual System Germany, while the decisions that determine the amount of those fees are taken elsewhere. In this situation an optimisation of the Dual System fees by changing the packaging is difficult. Here, a better co-operation between Sony Germany and the responsible people for packaging and product design is necessary.

It should also be noted that some environmental management costs are not included in the environmental management costs of Sony Germany. Those costs e.g. are costs for research and development in order to facilitate recycling, which is done by Sony Europe.

Those costs are part of the product transfer prices, but there is no possibility of determining them. This, however, is necessary to determine the costs of a prospective electronic product recovery and recycling ordinance, which is attempted in the second part of this case study.

As already mentioned above, the environmental department not only wants to have more information about the general environmental costs, but also about the costs of the environmental management system in particular. These costs are identified in the case study.

So far no revenues have been achieved through the environmental management system. It is planned though, to charge the departments that are certified against the ISO 14000 standard for the service the environmental departments renders them in keeping up the system and the certification. However, those fees are internal transfer prices and no revenues.

Revenues could be achieved, if the environmental department succeeded in offering paid services connected with the environmental management system to outside parties. This was considered for the education of suppliers.

Another form of revenues might be incurred, if the environmental management system lead to direct cost savings. This could be the case, if insurance premiums were lowered as a consequence of the system being in place. So far, no such revenues could be identified.

7.1 Review of the current accounting practices for environmental costs and suggestions for improvement

The ECOMAC project aims at illuminating the relationship between environmental management and management accounting in companies. At Sony Germany this relationship has two aspects. On the one hand does the environmental department give information to the accounting and management accounting system. This is the case for cost data concerning waste disposal costs and data concerning the classical environmental costs of Sony. On the other hand does the management accounting department control the environmental department concerning the costs that this department incurs or is responsible for. This control also refers to the information the environmental department delivers to management accounting. The control of information includes the features completeness of the information, correctness and reliability.

One of the goals of this case study is to make environmental costs transparent. This transparency has two aspects. To be transparent, first, environmental costs have to be identifiable as such and secondly, they have to be allocated to products and processes in a way that reflects the part those products and processes took in causing the environmental costs. The allocation should also reflect the parties responsible for incurring the costs and/or the parties able to change the costs. In the case of Sony Germany there is no production process. Instead, a distribution and service process can be found. Products

are bought from Sony factories and then resold. Therefore, it was not possible to determine the environmental costs that products cause during the production process.

8 *Determining the costs for the recovery and recycling of used products according to the prospective Electronic Waste Directive*

All costs that might result from the prospective Electronic Waste Directive will be addressed as electronic waste costs. The definition chosen for the term 'electronic waste costs' is the following:

'Electronic waste costs include all goods and services sacrificed for the recovery of used electronic products from the end users and the recycling of those products. The electronic waste costs also include costs the producers incur to facilitate the recovery and recycling of their used products. The electronic waste costs are net costs, therefore, all gains achieved from recovery and recycling activities have to be subtracted.'

The electronic waste costs contain costs for the following activities:
- Collection of used products,
- sorting of used products,
- storing of used products and their components,
- transport of used products and their components,
- dismantling of used products,
- reuse or recycling of component or materials from used products,
- disposal of components or materials from used products,
- administration for the recovery and recycling system,
- research and development to facilitate the recycling of used products.

9 *Conclusions*

One goal of the ECOMAC project is to determine the role of management accounting for environmental management. This role is characterised by generating and exchanging information. At Sony Germany cost information is mainly flowing one way, from the environmental department to the management accounting department. The department of environment, safety and quality delivers information on the costs it manages (mainly waste disposal costs) to the accounting and management accounting department. The management accounting department has a controlling function. On the one hand it controls the cost data delivered by the environmental department along the characteristics completeness, correctness and reliability of the information. On the other hand the management accounting department does performance measurement and budget control for the department of environment, safety and quality. In this research both departments gave valuable information. The management accounting department helped the environmental department by providing information on the allocation of different cost items. For the study on environmental costs, the management accounting department also gave background

information on the cost accounting system, product costing and other management accounting functions.

This case study focuses on environmental costs. To be aware of their environmental costs helps organisation in taking correct decisions. Those decisions may include decisions concerning product costing, capital budgeting, process changes, make or buy decisions, etc. Sony Germany is not a producing company, instead, it only does distribution and service, while buying the products from producers. Therefore, the environmental costs of interest are different from those of a producer. The environmental costs of interest for Sony Germany are mainly the costs of environmental management, energy supply, all waste disposal costs and the costs of the prospective Electronic Waste Directive. If this directive should come into force, producers and distributors of electronic products will be forced to recover those products at the end of their useful life time and to recycle them as far as possible.

Sony Germany has already installed an environmental management system for part of the Cologne site and an expansion of the system over the whole site is planned. This system, however, does not account for all environmental management activities of the department of environment, safety and quality. Additionally, all waste streams on the different sites are co-ordinated and managed by this department. In future this will also be the case for all energy, gas and water consumption and the wastewater streams. The environmental department also co-ordinates the payment of fees to the Dual System Germany, which disposes of the sales packaging of products and for a similar system disposing of the transport packaging.

Since the environmental department gives valuable services to the organisation, there is a wish to know more about the exact costs and benefits of those services. This serves two purposes. The first purpose is to get a clear idea about the cost/benefit situation and information that might be used for justification purposes, if the need should ever arise. The second purpose is to create a base for charging other parts of the organisation for some of the services they receive from the environmental department.

Concerning the costs of the prospective Electronic Waste Directive, producers and distributors for some time have been aware of the threat of having to recover used products. They have not been idle. On the one hand research is done to determine the financial outcome of such a recovery duty. On the other hand efforts are made to design new products in a way that facilitates recycling and to develop new procedures for the recycling of older models. It should be noted though, that those actions mainly refer to the German market and the producers operating in it.

The German branch of Sony's television division already did research and developed a recycling friendly television. This product is produced using less material, fewer different materials, no combination materials and it is easy to dismantle. It turned out that due to the use of less raw materials this product line also can be produced cheaper than con-

ventional televisions. This example demonstrates that legislation like the Electronic Waste Directive not only leads to costs for companies, it can also be used to create competitive advantages.

Still, to prepare for the impact of the Electronic Waste Directive, it is necessary to have information about the costs to which different conditions of this prospective directive would lead. This case study provides a framework for the calculation of the recovery and recycling/disposal costs for used products. The framework can be adapted to different scenarios concerning the payment, collection, sorting, transporting, storing, recycling/disposal and administration for such a system. Thus, the costs for different scenarios can be calculated and compared. As can be seen, the framework can be used as a guideline to calculate environmental costs for a specific purpose. As such it helps the environmental department in collecting the right cost data from external information sources (e.g. associations, recycling companies).

Evidently, the environmental department of Sony Germany is interested in making environmental costs and future electronic waste disposal costs transparent. It is uncertain, however, whether this information will be used optimally for decisions concerning product design and product packaging. Those decisions are not made by Sony Germany, but by product managers elsewhere. Here, a communication problem exists and new communication channels are needed to make sure that the environmental cost information is considered for such decisions. In this respect special difficulties might occur, if products are produced and packed outside Germany. There, product managers might have little idea about the environmental costs that are a consequence of German legislation (Packaging Ordinance, Electronic Waste Directive). Still, Germany is the largest market for Sony in Europe. Consequently, not changing product design and packaging might turn out to be expensive for the organisation as a whole.

This study leads to the conclusion that the management accounting department does not play a role in every case of calculating environmental costs. However, in the case of calculating the costs of environmental management at Sony Germany, the management accounting department delivered important accounting information. Since the environmental department does not have much experience in calculating cost figures, the framework established in this case study might be of great value for managing environmental issues in a cost-effective way.

Abbreviations

A&P:	Advertising and Promotion
BPE:	Broadcast and Professional Europe
BPG:	Broadcast and Professional Group
BUM:	Bundesumweltministerium (German ministry for the environment)
BZN:	Bürozentrum Nord (building)
CAV:	Consumer Audio/Video
DB:	Deckungsbeitrag (gross profit)
DM:	Deutsche Mark
ECE:	Environmental Centre Europe
EDV:	Elektronische Datenverarbeitung (electronic data processing)
G&A:	General and Administration costs
GmbH:	Gesellschaft mit beschränkter Haftung (Ltd)
h:	hour(s)
HQ:	Headquarters
IPG:	Information Product Group
ISO:	International Standard Organisation
ITG:	Information Technology Group
ME:	Mobile Electronics
MS:	Management System
LCD:	Liquid Crystal Display
NCS:	Non-Consumer Service (professional)
NDC:	New Distribution Centre (building)
nr:	number
NUS:	National Utility Service
PE:	Polyethylene
PCB:	Polychlorinated Biphenyl
PVC:	Polyvinyl Chloride
RM:	Recording Media
RMA:	Recording Media Accessories
RMG:	Recording Media Group
s:	seconds
SAP:	Systeme, Anwendungen, Produkte in der Datenverarbeitung (company and software name)
SCS:	Sony Consumer Service
t:	ton(s)
TV:	Television
UBA:	Umweltbundesamt (German federal environmental administration)
VDMA:	Verband Deutscher Maschinen- und Anlagenbau e.V. (association)
ZAV:	Zentrale Allgemeine Verwaltung (central general management)
ZVEI:	Zentralverband Elektronik- und Elektroindustrie e.V. (association)

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4.1.3 Relevant environmental cost information concerning IBM's Logistics Center in Germany

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Jan Jaap Bouma

1 Introduction

This report focuses on environmental costs of a specific operation at IBM Germany. First the company is described. The environmental challenges are identified. The company uses several management systems and tools to deal with the environmental challenges. In this respect environmental management is described. An outline of management accounting systems and techniques is presented and its relevancy for environmental management is illustrated. A specific need for information on environmental costs is focused upon and it demonstrated how this cost information is generated.

IBM is in the business of developing, manufacturing and selling advanced information processing products throughout the world. These products include computers, microelectronic technology, data storage devices, storage devices, software, networking and related services.

The total revenues in 1995 were $ 71,940 million and a gross profit of $ 30,367 million. IBM's business economic objectives focus increasingly on revenue growth, introduction of new offerings in the network computing market, and aligning the cost and expense structure in strategic solutions areas. The company's capital expenditures for plant, rental machines and other property were in 1995 $ 4.7 billion. The company continues to invest in high-growth advanced technology areas such as micro-electronics and in the managing of customers' information technology as part of the company's rapidly growing services business. At IBM there are 219,839 employees (1995) of whom 21,347 belong to IBM Germany.

2 Environmental challenges

Within IBM the specific environmental challenges vary between the different sites that are responsible for manufacturing, hardware development and research. Generally, IBM faces the environmental challenges of product stewardship. In relation to this challenge five objectives as priorities for all new products are formulated:

1. Develop products with consideration for their upgradability to extend the product's life.
2. Develop products with consideration for their reuse and recyclability at the end of the product's life.
3. Develop products that can be disposed of safely at the end of the product's life.
4. Develop and manufacture products that use recycled materials where economically and technically justifiable.

5. Develop products that will provide improvements in energy efficiency and/or energy consumption.

The new German Eco-Cycle-Law ('Kreislaufwirtschaftsgesetz') on waste management (effective by 7.10.1996) describes a general product responsibility of manufactures for used products. This law will be specified by issuing several ordinances. IBM is directly influenced by the ordinance on the disposal of information technology equipment (IT Equipment Ordinance). In this case study the focus is on the need of environmental cost information in relation to the recovery of used products.

3 Environmental management

In 1967, IBM began establishing corporate policies on safety, environmental protection and conservation. Over the years, these policies were updated and, in 1990, they were consolidated and expanded when the Corporate Policy on Environmental Affairs was issued. In 1995 the Corporate Policy was updated and reissued.

The policy provides the framework for environmental objectives. These objectives are detailed further in corporate instructions and are fundamental to IBM's overall environmental management programmes. The instructions include such areas as energy management, hazardous waste vendors, incident prevention and reporting, environmental evaluation of suppliers, industrial hygiene and safety programmes, and environmental impact assessments. The technique of environmental impact assessment is used to describe and evaluate environmental impacts of products, processes and sites. For detailed evaluations the LCA-technique is used. These studies are performed in the USA and coordinated by a IBM research center that is also located in the USA.

IBM has maintained an environmental management system over many years, believing it to be an essential element behind a company's commitment to environmental protection. IBM Mainz has received EMAS registration and is certified according to ISO 14 001. Within the German locations the environmental management is designed to be in compliance with ISO 14 001. Concerning the environmental management systems Internal Audits are an important management tool.

The environmental performance is measured against external and internal requirements, such as its Corporate Instructions, through a comprehensive set of audit programmes. Each year, all manufacturing sites undergo self assessments. They also are reviewed periodically by their peers at other sites. Moreover, a number of facilities are audited annually by Corporate Internal Audit, with results communicated to top management with accountability clearly established.

4 Management Accounting

The importance of the management accounting system for environmental management is considered as considerable by the controller of IBM Mainz. This is a result of the man-

agement accounting procedures (capital budgeting procedures) that are also applicable to environmental decisions. An important feature of the management accounting system is the allocation of environmental costs. This allocation is based on the regular accounting policies. The allocation basis ('Umlageschlüssel') is sometimes adapted if necessary. For environmental management the allocation of costs is important as the costs of environmental impacts and environmental management influence the profitability of the different parts of the company.

All regular elements of management accounting exist at IBM. The bookkeeping system of IBM Mainz is based on a full absorbtion method of cost-accounting and shows the actual costs of the company. The budgeting process for overhead is done by 'Service Level Agreements' where cost centers like water supply negotiate agreements with production cost centers as to how much of a product or service has to be delivered and at what price. The budgets are planned and controlled. There is a comparison of planned budget and actual expenditure. The results of this comparison are reported to the management. Capital budgeting is co-ordinated by an investment plan for every production unit. This plan is based on the planned capacities and projects of a unit. This planning is done by the individual business units in correspondence with the targets set for them by the corporate management. The product costing is done by using full absorbtion costing. The manufacturing product costs are calculated with the weighted average costing method. Thus the product costs is the average of all the product costs of specimens of this product in stock. The transfer price for product delivery between IBM units equals this calculated cost price. For IBM companies outside Germany, IBM Mainz adds ten percent to the calculated cost price.

With regard to the recovery of used products the accounting rule for transfer pricing is important. The net costs of taking back used products is highly determined by the revenues of reusing compounds within IBM. Those parts of a disposed computer that are to be reused are sold by IBM Germany to IBM in Amsterdam (the Netherlands). For the delivery of these computer parts the paid transfer prices are the revenues to the unit that dismantle and sort the disposed computers. These transfer prices are equal to 25% of the cost price of a similar new part of a computer. The IBM Logistics Center Germany is responsible for the dismantling and sorting of used computers and hence accounts the transfer prices for reused parts as income. The actual costs at this site are allocated by using activity-based costing (see paragraph 5.2).

5 *A specific need for information on environmental costs*

The management of used and discarded products is part of the 'Product Stewardship programme' and is stimulated by developments in legislation. In this respect the IBM Logistics Center Germany (located at Mainz) dismantles and sorts used computers. In 1995, IBM processed in these reutilisation centers more than 8 million pounds of discarded

equipment collected from IBM facilities and customers. More than 85% of this equipment was repaired, tested, and reused or dismantled and raw materials are recycled.

For decision making (for example with regard to product design and price setting) there is a need for cost information with regard to the IBM Logistics Center Germany. Within the IBM corporation there is no general definition of environmental costs. However, for specific environmental issues there is a need to calculate the costs of environmental activities. In the case of the take back center this location is devoted to an environmental activity. Until now this is a voluntary activity. In the light of future legislation the take back of used products will become mandatory. The total costs related to this center could be considered as environmental costs.

Still, the establishment of this center is not only based on environmental arguments. Other arguments are:
- marketing reasons (there is a market for reusing equipment and spare parts)
- asset control.

From a management point of view it does not make sense to make general statements on the total amount of environmental costs (costs that result from activities to achieve the corporate environmental objectives). No decisions are made that ask for this cost information. However, within IBM at least the environmental and accounting departments are confronted with the need to calculate the cost of disassembling, recycling and disposal of used products. Because these activities reduce environmental impacts they can be classified as 'environmental'. Hence, the costs of disassembling, recycling and disposal can be regarded as 'environmental costs'. An important reason to have insight into these costs is to decide on the efforts to achieve a higher recycling efficiency (for example the use or exclusion of specific materials and the effort to prevent disposal by searching for novel uses for recycled materials). In the light of the IT Equipment Ordinance (see paragraph 2) the need for information about the costs of disassembling, recycling and disposal increases. IBM needs to know the costs that result from the product responsibility for manufactures for the following purposes:

1. To assess the financial consequences of the IT Equipment Ordinance. This information is an important input for the negotiation on the formulation of the IT Equipment Ordinance.
2. One of the consequences of the potential increase of costs of the possible IT Equipment Ordinance would be the need to establish accruals ('Rückstellungen'). When the Ministry of Finances would accept the establishment of accruals for this purpose, IBM gains the benefits of lower tax expenses. For the acceptance of these accruals accurate estimations of the future costs of disassembling, recycling and disposal should to be provided to the tax agency.
3. Accurate calculation of cost prices. To establish accurate cost prices the costs of disassembling, recycling and disposal have to be allocated appropriately to the products

that are to be reused. This cost information is needed for decisions about the prices customers have to pay when they return the used products to IBM.

5.1 The generation of information on environmental costs

Assessing the financial consequences of the IT Equipment Ordinance there is a clear need for information on the costs of disassembling, recycling and disposal of products that are to be sent to IBM as a direct result of the legislation. To obtain this cost information the environmental staff department made 'ad hoc' inquiries. The staff environmental co-ordinator contacted the environmental co-ordinator at the site that is responsible for disassembling and recycling. The environmental co-ordinator at site level gathers data on actual costs of the products that are presently disassembled, recycled and disposed. This cost data is obtained from the department responsible for accounting. A problem of understanding the cost information may occur as some accounting policies are unknown to the environmental officers. This could result in over- or underestimating the costs of the future IT Equipment Ordinance at the environmental department. For example, there is unclarity with regard to the allocation of overhead costs to the activities related to the return of used products and the disassembly. However, within IBM the exact cost calculations are not to be performed by the environmental department but by the accounting department. Therefor an over- or underestimation of the costs of the future IT Equipment Ordinance is therefor less likely to occur.

The generation of cost information in order to establish accruals demands the consideration of accounting rules imposed by the legislation on accruals that are to be accepted by the tax agency. Such restrictions are not apparent when the costs of disassembling, recycling and disposal are calculated to negotiate with the government on the draft versions of the IT Equipment Ordinance. Within IBM the accounting department is not yet performing the cost calculations to establish accruals for future environmental costs that result from the future IT Equipment Ordinance.

Also, with regard for the calculation of costs prices of the products for which recycled materials are used, information on the costs of disassembling, recycling and disposal is to be generated. This is not typically the responsibility of the environmental officers. However, the environmental staff department is interested in having information on the impact of the different products on the disassembly, recycling and disposal activities. This cost information is obtained from the accounting department, that acquires it by using the technique of activity-based costing (ABC).

The same accounting systems and techniques are used to generate the cost information on disassembling, recycling and disposal for the assessment of the future IT Equipment Ordinance to calculate the cost prices. The historic costs of disassembling, recycling and disposal of used products transferred to IBM in a past year are assumed to be the future costs for the coming year. This was indeed the case for the past five years. For the past five years the costs of the disassembling, recycling and disposal of used products re-

mained more or less the same. For the generation of this cost information ABC is used. ABC is a technique to more accurately assign direct and indirect costs to the activities (including environmental) and to the customers or products which consume organisation resources. ABC is used by performing several steps.

The ABC-process starts with the identification of the resources. In addition to the identification of resources the activities that take place at the IBM Logistic Center Germany are defined and located. Finally, the cost objects are defined. The use of resources is allocated by identifying the extent to which a cost object (final products, services to corporate level of IBM, etc.) needs the activities. The use of an activity is expressed in a measurable unit for which a cost rate is determined.

By using ABC cost information is generated with regard to the returns and scrapping (dismantling, recycling and disposal) of used computers. The total net costs per kg used computers can be obtained. Additionally, ABC provides insight into the activities that are responsible for these costs. Therefor ABC assists in increasing cost transparency.

Although, ABC is used there remains a portion of costs that is regarded as overhead. These cost could not be allocated in an unarbitrary manner to the returned (used) computers. Without using ABC the proportion of costs that would be considered as overhead would be significantly larger.

By using ABC costs expectations can be made. The costs per kg returned computers may decrease as a result of an increase of the total kg's of returned computers. Namely, the total fixed costs are to be allocated to a larger number of used computers. The net costs of scrap per kg in 1995 and 1996 was about Dm 1.00.

Relevancy of the information on environmental costs

On the basis of information on the costs of returning and scrapping of used computers IBM can set prices that have to be paid by those who return their computers. In this respect IBM has seven categories for used computers. Depending on the weight of a computer a fixed price has to be paid. The prices range between 50,- DM for Category 1 (e.g. PC's) and 4.200,- DM for Category 7 (e.g. Mainframes). It is assumed that the average costs of returns and scrap of computers that belong to a category equal the revenues.

Some difficulties in calculating environmental costs

The cost information that is obtained by using ABC provides an important information basis for the issue of price setting. However, there are some problems with the reliability of this information. This is the result of the use of ex-post accounting data and the uncertainty with regard to the total amounts of used computers that return. The use of ex-post accounting data is a problem because costs figures of the past may change in the future. For example, the costs of external recycling may increase dramatically. Also, the revenues for precious materials that are recovered, may in- or decrease because these reve-

nues depend on the market prices. The uncertainty with regard to the total amounts of used computers that return is a problem because this number is needed for the allocation of the fixed costs. An overestimation of this amount would result in an underestimation of the costs of returns and scrap per kg used computer.

6 Conclusions

The IBM case shows the role of traditional management accounting systems (bookkeeping system and ABC) in generating cost information for the environmental manager. The case shows a specific need for information on environmental costs. It is confirmed that presently the management of the company has less need for information on environmental costs when these costs are broadly defined.

With regard to the use of common management accounting systems (bookkeeping system and ABC) it is noticed that while these systems generate useful information on environmental costs other problems appeared when thin information is used for price setting. These problems are caused by the nature of accounting date. Namely, this data is ex-post. For price setting there is some uncertainty about changes in the cost figures. The questions arises if the net costs of returns and scrap will increase or decrease. Other techniques, such as sensitivity analysis may be helpful in overcoming the problem of having only (ex-post) accounting data.

4.2 Company-based experience in eco-management accounting: four case studies in Italy

4.2.1 Environmental liability costs and risk management at Italiana Petroli SPA

Giorgio Vicini

1 Description of the company and its environmental effects

Italiana Petroli(IP) is a company of the ENI-group and operates in the petroleum downstream sector. IP produces and distributes lubricating oil and gasoline, and has about 1600 employees, 4.200 service stations, 14.000 service station managers and an eight billion ECU of annual sales.

The IP organisation is divided in a central division, a marketing division and a logistic and distribution division. The central division provides services to the other divisions. The marketing division comprises the service stations that sell products to consumers. Finally, the logistic and distribution division manages the bulk storage and transport of the products.

There is a Health, Safety and Environment manager who is reporting directly to the president. This HSE manager provides the guidelines for the policies on environment, health and safety to the divisions and is responsible for their implementation.

Main environmental effects of IP are related to product toxicity, soil pollution and emissions to air.

The major environmental problem for IP is the risk for oil spills from service station tanks. The paper focuses on the financial implications of reducing this risk. In order to reduce this risk in a proactive and cost-effective way, IP has set up the so-called Ecostart project. This project aims to identify the service stations and the tanks which have the highest risk for spills.

Another important environmental issue is the prevention of the emissions of volatile organic compounds (VOC). IP is anticipating legal regulations in this field, and is investing 43 million ECU the coming five years for VOC recovery provisions at service stations.

As to product toxicity, IP is constantly developing processes and raw materials that reduce toxicity and other environmental harm. Large investments have been made in this area.

Wastes from production are delivered to disposal companies for reuse or appropriate disposal. Also, IP is a member of the 'Consorzio obbligatorio oli usati', an organisation for the collection of used lubricating oils. These oils are then used for reuse or for combustion conform government regulation.

In order to save water, a project is being implemented aimed at re-using wastewater at the bulk storage terminals and from the car-washes at the service stations. For instance, used water may be reused as fire abatement water.

2 *Environmental management*

IP is a member of the ENI SpA group, which has a proactive environmental strategy. The guidelines for this strategy have to be followed by IP as well. Part of this is the requirement to produce an environmental report. As the ENI group is quoted at the Wall Street Stock Exchange, the USA Security Exchange Commission requires a synthetic environmental report every four months. Environmental management today is not only a matter of ethics, but also a strategic and financial matter.

The Environmental Management System consists of a number of qualitative targets, the Environmental Report, and the Environmental Audits.

The first Environmental Report was published in 1997 as a result of an extensive data collection over the years 1994 to 1996. The report follows the methodology of FEEM, which in turn is based on the EUROSTAT and PERI (Public Environmental Reporting Initiative). A result of this is that the accounting methods have been modified in order to give better insight in environmental costs.

IP uses a computer programme called Environmental Information System for maintaining a database on environmental figures. The system is based on the methodology of the environmental balance sheet. It gathers and analyses physical data on:

- inputs and their financial values
- products and their financial values
- emissions and their related environmental expenditures.

These three groups of data are combined during analysis in order to discover possibilities for increasing efficiency and reducing the impact on the environment. The system can group the figures by production site or by kind of activity. This is useful in communication with local communities and for comparing environmental performance indicators with legal limits.

Environmental audits imply the collecting of structural data on the oil tanks, both at the service stations and at the bulk storage and production sites. These audits are carried out periodically at all of the bulk storage sites and most of the service stations. Items reviewed include characteristics of the tanks (age, capacity, type), stratum, lithology and wells. The audits are an important tool for the management, but the results may in the future also be used in the EU project 1836/93 (EMAS). Especially important are the results in the Ecostart project for identifying the service stations with the highest environmental risk, because this enables prioritising the investments in safer and cleaner plants.

3 *Management accounting*

The accounting system of the company reflects the organisational structure. Costs are gathered in cost centres that correspond to the three main divisions of the company, that is marketing, logistic and distribution and the central division. Each division has in turn many specific cost centres which correspond to specific responsibilities of the managers. Therefore a cost centre can be described as a responsibility centre where managers are accountable for the costs under their control.

IP follows the accounting guidelines of the EU, the Italian association of accountants and of the ENI corporation. As to environmental accounting, IP follows the EPA definitions of conventional environmental costs, except labour costs in some cases. However, in the case of specific investment decisions, the environmental manager and the controller will collect any specific environmental costs that are relevant in the decision process. This means that a difference is being made between costs and investments. For an investment a separate cost centre is made and all relevant costs are allocated to this.

Up to now IP has not had any provision for environmental liabilities from environmental damage inflicted in the past, but IP is in the process of making such provisions.

3.1 Environmental Accounting

1. The environmental costs at the first division, the central division, are very low. Only the most specific environmental costs are gathered as environmental costs here. All other HSE costs are recorded as overhead costs. This includes service station monitoring and the production of the environmental report.
2. In 1996 the logistic and distribution division has shifted to a new accounting system for environmental costs. IP adopted the ENI classification of environmental costs, which is based on EU definitions. The same accounts are used for setting up the budget for the coming year.

   The main accounts are:
   1. Air and climate protection
   2. Water protection
   3. Soil and underground protection
   4. Environmental reclaim
   5. Environmental monitoring
   6. Wastes
   7. Health
   8. Noise abatement
   9. Safety and fire protection
   10. Training and information.

Each of the 7 storage sites are costs centres where these costs are collected. The main environmental cost is that of collecting and disposing responsibly of used oils. (This is re-

corded under 6: Wastes.) Insurance costs are recorded under overhead costs as it is difficult to allocate them to specific storage sites. Environmental costs are gathered every month in an intermediary report.

3. The marketing division comprises 9 branches, covering all regions of Italy. Every branch is a cost centre. The following environmental costs have specific accounts here:
   1. Disposal costs
   2. Soil and ground-water pollution prevention
   3. Washing softener (= carwash)
   4. Washing softener (= carwash) maintenance
   5. Environmental maintenance costs
   6. Safety costs

Highest costs fall under category 2. for the replacement of tanks by double skinned tanks, and at category 1 for the final decommissioning at the end of the life of the service stations.

The costs of VOC recovery are seen as an environmental investment, and are therefore recorded in a separate account. This investment is estimated to 43 million ECU over the next five years.

The controller of IP estimates that 5 million ECU are not recorded in environmental accounts but in overhead accounts.

The accounts are also used for budgeting and control. There is a three month budget, an annual budget and a five year budget. The budget and control operations are used for all cost types, including environmental.

There are no strict procedures for investment decisions. Common criteria are used, such as return on assets, return on investments, net present value, and internal rate of return. Investments and their financial implications are incorporated in the five year budget.

4 Problem definition

The main environmental issue at IP is environmental risk management, especially the risk of oil spills. Cleaning up spilt oil is an expensive matter, and prevention was expected to be much cheaper in the medium and long run . However, IP covers 4.200 service stations, and making all of them environmentally safe is an expensive task.

5 Response: cost-effective risk management

In 1995 the Ecostart project was started in order to shift from repairing and reclaiming environmental damage to preventing it. This was believed to give better results, both financially and for the environment.

In this project a wider definition of environmental costs was used than in standard environmental accounting, including future liabilities for environmental damage and image costs (costs for public relations). These costs may be incorporated in the Environmental Information system in the future, but not in the financial accounting system because evaluation of these costs often is too subjective.

The project could be regarded as a cost-benefit analysis with a fairly extensive definition of environmental costs. The project consisted of two parts: first the service stations with the highest risk were determined using statistical methods in order to avoid having to audit all 4.200 stations. Then financial calculations were made to determine profitability over the coming three years of investing in safer plants (mainly tanks). In the Ecostart project different managers like the HSE manager, the controller and the communication manager, co-operated.

5.1 Identification of High Risk Service Stations

Every station has on average 4 tanks, resulting in some 16.000 IP tanks in the whole of Italy. Just the monitoring of these tanks is an expensive activity. Therefore, IP identified the main factors that determine the risk for environmental damage and used this to predict what stations had a high risk.

The main determining factors are:

- management factors: number of thanks, quantity of oil turnover, frequency of oil level measurements by pole, quality of maintenance and control, scrutiny in loading of the tanks;
- information factors: how experienced and trained is the station manager?
- technical plant factors: age of the tanks, number of oil pumps, technical data on the tanks, quality of the tanks, etc.
- area characteristics: soil humidity, height over ground water level, physical and chemical soil characteristics like acidity.

67% of the station managers were asked about a number of the determining factors. Furthermore, a representative sample of 121 stations was monitored for the chemical and physical factors. The most critical risk factors turned out to be ground water level (= stratum level), lithology (type of soil), tank weight, presence of water wells, number of oil spills in the past, and the number of tanks at the station. From the collected data, using statistical methods it was possible to attribute an estimated risk score to each service station. This score was then be used in the investment decision process, giving priority to those stations that had a higher risk. 16% of the stations were identified as having a 'higher risk'.

5.2 Economic Evaluation

IP will implement a proactive, preventive strategy at the higher risk stations, and maintain an 'end-of-pipe', curative policy at the others. The preventive policy implies that tanks are replaced by double skinned tanks.

An economic analysis showed that if future liability costs, image costs, insurance costs and other contingent costs are taken into account, the preventive strategy is profitable in the medium-long period.

The available data and the model enabled calculating the optimal number of stations that should be renovated. The condition for investing in a station is that the estimated avoided costs of oil spills are higher than the costs of prevention. In 1995 the number of stations that met this condition was calculated to be 144.

In the calculations the following environmental costs were used in a quantitative form:
1. Measurement and treatment
2. Substitution and repair
3. Monitoring and reclaiming

The following costs were not quantified, but were taken into consideration in a qualitative form:
1. insurance costs
2. legal costs
3. fines and penalties
4. fall in operating risk
5. image costs
6. brand loyalty
7. legislative changing risk
8. capitalisation of management costs

However, including these costs would only show that prevention is even more profitable than the present calculations do, because most costs favour prevention. The effects on the income statement are negative the first year, but in a medium period effects on both income statement (profit-loss account) and balance sheet (assets) are positive.

Calculations have been made for three years, comparing the results on the income statement and the balance sheet. In the first year the costs of the preventive measures press on the income statement. But already at that time the balance sheet is positively influenced thanks to the increased value of the company because it has better, more valuable tanks. The costs of reclaiming still weight on the income statement due to spills from the past. But in later years these reclaiming costs are reduced, while assets further increase.

6 Conclusions

Environmental accounting, which developed spontaneously at IP, revealed profitable investment possibilities, and thus combined environmental care and profitability. Although this was no preset goal, accounting practices developed in the direction of the EU regulation 1836/93 (Emas).

Furthermore, the assessment of the high risk service stations, actually a search for the most cost-effective investments, opened up for negotiations on the insurance costs. However, a number of environmental costs are not accounted for in a quantified way yet.

4.2.2 The allocation of environmental costs at SGS-Thomson Microelectronics

Stefania Borghini

1 Description of the company and its environmental effects

SGS-Thomson Microelectronics (now: ST Microelectronics) is a global independent company that produces a broad range of semiconductor integrated circuits. Its products are used in telecommunication, computers, consumer electronics, automotive and industrial sectors. The company is the world's leading supplier of analogue integrated circuits, mixed signal integrated circuits, smart power integrated circuits and MPEG decoder integrated circuits. SGS-Thomson sell to customers in a variety of markets world wide, including North-America, Europe, Asia (mainly Pacific and Japan).

There are divisions for the following products:

- Dedicated Products
- Programmable Products
- Discrete & Standard Integrated Circuits
- Subsystems
- Memories
- New Ventures

SGS-Thomson has manufacturing sites in Europe, USA, South-East Asia and North Africa. This case study is concentrated on the analyses of the Agrate site, one of the three sites in Italy.

The production process can be divided into the front end phase and the back end phase. The front end implies the production of the integrated circuits and is the technologically most advanced part of production. The back end is assembly, testing and finishing.

A simplified description of the manufacturing process is given below:

1. Raw materials purchase and storage: the basic raw material is silicon wafers, the thin layered starting material. The other major process related raw materials are different kinds of chemicals.
2. Photolithography: the wafer is coated with a special organic resin dissolved in non-chlorinated solvents. The wafer is than exposed to ultraviolet light through a 'mask', in order to print integrated circuits on the wafer. The parts of the resin exposed to the ultraviolet light are than washed away with caustic fluid.
3. The resin left on the wafer is removed with acids.
4. Etching: the exposed areas of the wafer are then etched with corrosive materials based on hydrofluoric acid.
5. Doping: the etched parts of the wafer may be doped with small quantities of certain chemicals which change the electrical properties of the silicon.

6. Assembling, pre-production and testing: the wafers now have a series of integrated circuits. They are now cut, attached to metal leads, enclosed in protective casing and tested before leaving the factory.

As the description of the production process shows, a number of potentially dangerous chemicals are used. At Agrate the main activity is the front end part of production. Apart from the mentioned chemicals, de-ionised water, special gases, compressed air, electricity and natural gas are used.

The Agrate site is structured in four main sections:

1. Production Activities: These take place in three manufacturing locations: F8, F3 and R1.
   In F8 and R1 mainly memories and programmable products are produced;
   In F3 bipolar and mixed technologies and dedicated products are produced.
2. Divisional Activities: these are activities for different divisions, such as design, research and development, laboratories, technical and marked support.
3. Technical Service Activities:
   - raw materials storage and distribution
   - chemicals storage and distribution
   - distribution of gases and acids
   - distribution of electricity
   - production of de-ionised water
   - spare parts storage
   - shipping of the products
   - conditioning monitoring equipment (monitors temperature, etc.)
   - waste storage
   - wastewater treatment
4. Administration Activities:
   - general services and monitoring
   - accounting and payment of wages
   - human resources management
   - general administration
   - purchasing of raw materials
   - maintenance of information technology (hard- and software)
   - legal affairs support
   - financial affairs

2 *Environmental management*

2.1 Environmental effects

Production at Agrate has the following significant environmental effects:

- Chemicals

Various potentially dangerous chemicals are used. The site has programmes to ensure correct handling and storage of chemicals in order to prevent accidents like spills, and limit damage in case an accident happens.

Energy

The site uses considerable amounts of energy, especially electricity.

Waste

The site produces hazardous and non hazardous waste. Most of the waste is sent to authorised plants for incineration, landfill or recycling. Some waste is sold directly from the site for re-use.

Wastewater

Various kinds of effluent are generated by the site, among which production water containing acids, cooling water, water used in air emissions treatment (scrubbers), rain water and cleaning water. Two separate plants have been build to treat wastewater containing fluorides and cyanides.

Air pollution

The concentration and quantity of pollutants emitted into the air are monitored regularly and are well below the legal limits. There are scrubbers installed for cleaning emitted air. Installation of more scrubbers is presently being considered.

Water

The site uses water from its own well. The water is de-ionised before use. 15% of the water used is recycled.

Noise

The equipment in the outer area of the site can emit noise beyond the border of the site. The production of noise is monitored on a regular basis.

2.2 Environmental management

SGS-Thomson has changed from a 'follow-mode' towards a 'pro-active mode' regarding environmental policy. It is now recognised by SGS-Thomson that environmentally friendly technologies are usually also leading-edge and more efficient ones. The company is working on reaching the EMAS standard for all sites by the end of 1997.

In the organisational structure, Environmental management is strongly related to quality management. At each site there is a so-called Site Environmental Champion. Further-

more, there is an Environmental Steering Committee both at each site and at corporate level. In these committees all functions that have anything to do with the environment are represented.

SGS-Thomson has a number of tools for environmental management. The main are:

- Environmental Decalogue: This contains 10 environmental commandments, and is meant both for internal and external use.
- Corporate Environmental Management Manual: This contains the organisational units involved in environmental management, corporate environmental policy, and environmental procedures, standards and specifications. Also this manual gives guidelines for the site environmental manuals, and plays an essential role in the implementation of EMAS.
- Site Environmental Management Manual
- Site Annual Environmental Balance: This document lists physical quantities and costs of materials and energy form used at Agrate, and is filled in every 3 months.
- Site Environmental Progress Report: This document describes all the site environmental projects (implemented, in progress, waiting for approval and under consideration) and the specific annual targets for the site as established on the basis of the corporate objectives. Until now those target have been defined in absolute terms or as relative to the sales value. For example, reduce total energy consumed per million dollars sold by at least 5% per year.
- Environmental Effects Register.
- Monthly Materials Flow: this concerns consumption of gasses, electricity and water at the Agrate site.
- Environmental Data Bank: This is a relatively new tool in SGS-Thomson. It is to gather information from all sites in a uniform way, in order to have a complete view of the environmental performances of SGS-Thomson . If the data bank is fully implemented, it is to contain data on water use, wastewater discharge, air emissions, energy use, solid wastes, paper consumption, packaging, noise limits and monitoring results, and chemicals. For each environmental effect the physical quantities and compliance or non-compliance are recorded. For water consumption, wastewater, air emissions and waste some site costs are recorded. However, the data bank is not in full operation yet due to some implementation problems.

3 Management accounting

Costs are gathered in cost centres. A cost centre can be described as a responsibility centre where one manager is accountable for the costs under his control.

The cost allocation process has two main steps:

1. Trace costs to manufacturing locations (which represent the main manufacturing areas).
2. Trace costs to groups of products (product families).

The cost centres are divided into 'centres of costs' and 'centres of expenses.' These are treated differently during the allocation process.

The 'centre of costs' are traced to the manufacturing locations on the basis of a percentage. This percentage is defined at the beginning of the year, considering the different activities of each production area. The costs of each location are then traced to the whole range of products, principally on the basis of product movements and production volumes at standard costs. Product movements is the number of product movements in the production process.

In a second phase of the allocation process also the centres of expenses are traced to the groups of products, mainly on the basis of a billing percentage.

For budgeting so-called standard costs are used. Standard costs are the expected costs, based on costs realised in the past. Discrepancies from these costs are investigated in order to trace possibilities for reductions of costs.

SGS-Thomson uses the so-called cost of non-quality for discovering openings for quality improvement and cost saving. The costs of non quality are defined as the difference between the actual costs and the costs in a hypothetical perfect factory. Measuring these costs is hoped to identify ways of cost reduction and product improvement. These costs are measured at corporate, site and divisional level.

Proposals for environmental investments are judged in a different way from other investments. Environmental investments do not need to be financially feasible in order to be approved. These investments are judged on their contribution to the environmental goals and effects, as for example recorded in the Environmental Decalogue and the Environmental Effects Register.

4 Problem definition

There are two problems with environmental accounting in SGS-Thomson:

- only a few environmental costs are accounted separately,
- environmental costs are gathered at corporate and site level, but not at division level. This leads to discrepancies between environmental reports (that normally gather costs at site level) and other management and control documents that include data for divisions. Furthermore, since it is not the site that produces environmental effects but the divisions, environmental costs are not traced to their sources.

5 Response: the right cost information on the right place

In the SGS-Thomson corporation, a regular registration of well defined environmental costs is still lacking. However, when the Environmental Data Base is in full operation, this problem ought to be partly overcome.

In order to get a better overview of all environmental costs, the following steps are proposed:

- identify all environmental impacts
- identify measures taken to reduce these effects and their costs (Conventional Costs)
- Separate the environmental costs made for complying regulations, and those made for going beyond compliance.
- identify environmental costs that are not directly related to environmental effects, but to environmental policy in general (Environmental Overheads).

Environmental costs should be allocated to the management areas:

- air protection
- water protection
- waste treatment
- noise abatement
- soil protection.

Then these costs should be allocated to manufacturing locations on the basis of relevant cost drivers that as much as possible are determinant for, or correlated to the magnitude of the costs. Consumption of polluting material is a good cost driver in the cases of the costs of wastewater, waste management, air emissions and soil protection, because the more consumption of polluting material, the higher these costs are. On the other hand, some of these environmental costs may be more directly related to the quantity of emissions, in which case quantity would be a better cost driver.

The environmental overhead cost (cost where no distinct cost driver can be found) could be allocated to manufacturing locations on the basis of the allocation percentage of the other environmental costs.

Allocating environmental costs to manufacturing locations without differentiating between preventive measures and failure costs, could penalise the proactive divisions. Therefore it is important to distinguish between, as SGS Thomson has already done for non-quality costs, between four main categories of environmental costs:

1. prevention costs,
2. appraisal costs,
3. internal failure costs, and
4. external failure costs.

6 Conclusions

In the short term there is a need at SGS-Thomson to create at least two new cost centres, namely wastewater treatment and waste treatment, where all costs related to these two activities should be allocated to.

Also effective cost-drivers (like consumption of polluting material) should be identified, in order to allocate these two cost categories correctly at the divisional level.

Furthermore, the application of environmental codes to these cost centres will facilitate the use of those costs in the environmental data bank.

In the long run there should be an implementation of a separated environmental accounting system. That could be done following the four steps identified by this paper:

1. broader identification of environmental costs,
2. identification of suitable cost drivers,
3. tracing environmental costs to locations, and
4. linking management accounting, costs of non-quality and environmental accounting.

4.2.3 Towards a better insight into environmental costs at AGIP S.P.A.

Stefania Borghini

1 Description of the company and its environmental effects

Agip is the leading Italian oil company, present in four continents and 24 countries, often in joint ventures with the major international oil companies. Agip belongs to the ENI SpA group together with AgipPetroli SpA and SNAM SpA, and has over 8000 employees.

The oil production frequently involves long-term projects with different operational phases and considerable investments. Because of the characteristic features of the production process, the company presents some peculiarities: its realty is geographically widespread, and so is decision making authority.

Agip is divided into Production Units, Drilling Units and the Head Office. The Production Units and Drilling Units are aggregated in four geographical districts.

The Head Office has four management areas:
1. Exploration & Production Activities
2. Corporate Production services, including the Geodynamics and Environment Department
3. Corporate Exploration Services
4. Procurement

The production process consists of four phases:
1. Exploration: this is the phase of searching for possible exploitable quantities of oil and gas, by seismic surveys and exploration drillings.
2. Development: a feasibility study is done in order to determine economical profitability and optimal production facility design.
3. Production: the actual extraction of oil and gas.
4. Abandonment: when profitable exploitation of the remaining oil is no longer possible, facility plants have to be dismantled in a correct way: machines should be cleaned and all or part of the platform should be disposed of or reused elsewhere.

In general, the main categories of environmental impacts are discharges to water, solid wastes, emissions to air, raw material consumption and physical disturbance.

2 Environmental management

Environmental considerations are incorporated in all of Agip's strategies. The company acknowledges the importance of environment and safety. The main environmental management tools are the Environmental Impact Assessment and the Environmental Balance Sheet.

The Environmental Impact Assessment is performed on every proposed new long term activity, such as oil platforms. The results are part of the feasibility studies, and together with the technical and economical considerations, they influence the final design of the offshore hydrocarbons exploration projects.

An Environmental Balance Sheet, according to the FEEM-approach, is prepared for each Agip activity. The Environmental Balance Sheet relates the physical data on the environmental effects to the financial data. This tool relates environmental damage to the costs made to prevent or abate it. Three categories of data are collected:

1. Resources and Products,
2. Emissions,
3. Environmental Expenditures.

3 Management accounting

As there is only one product, hydrocarbons (oil and gas), costs are allocated to production and drilling units instead of to products.

When a new project is planned, a Project Management System is set up, in which the Activities, Sub-Activities and Jobs for the development of the project and the related costs are identified.

The identified costs flow into the budgeting system. The same system collects the forecasted cost centres. The system matches costs and costs centres in order to avoid duplication. In other words, the system identifies the amount of each cost to the activity that causes these cost.

This description of the accounting systems is necessary to understand how the peculiarities of the organisational structure and of the production process influence the accounting structure.

Most of the basic assumptions of environmental accounting theory have to be adapted in the case of Agip. All the problems related with cost allocation in this context are shifted from products to production and drilling units (items), since the product is only one: hydrocarbons. Moreover, the double accounting level, at corporate and items, allows to have a high degree of disaggregated accounting data.

The principle measure of capital investment decision-making is the feasibility study. Once it has been determined that an oil field is potentially economically attractive, the various production facility design options and production disposal routes are identified in the feasible study. The findings of the study provide basic economic, engineering and

The most common financial indicators used in Agip in these analyses are annual rate of return and net present value. For both indicators financial analysts use deflated cash flows. The time horizon is related to the economic life of the production field.

4 *Problem definition*

Agip is interested in improving insight in the environmental costs for three reasons:

1. Since Agip shares are quoted at the USA Stock exchange, the SEC requires that environmental costs are identified and published. In 1995 environmental investments amounted to 4.8% of all investments.
2. There is a general need to improve communication with stakeholders for promotion of the 'green face' of Agip.
3. Recent experience with the Brent Spar case shows that environmental costs can get very high, and that it may be necessary to make provisions for future liabilities in due time.

5 *Response: environmental accounting*

When Agip prepares an Environmental Balance Sheet they use the FEEM methodology, which refers to the EUROSTAT definition of environmental costs.

According to this definition, environmental costs are only those costs that are deliberately and principally made to prevent, control, reduce or eliminate the negative effects on the environment, without considering whether or not the costs had to be made because of legal requirements.

Expenses made for the purpose of costs saving, or for technical, safety or health reasons are not considered to be environmental costs, even if they have a positive effect on the environment. As this rule is often difficult in practice, the following criteria were used:

- If costs are made both for environmental and other reasons, only the estimated part of the costs that can be attributed to the environment is counted.
- In case of end-of-pipe solutions, the whole of the costs is environmental.
- In case of process-integrated solutions, either the extra costs relative to a solution without environmental benefits is estimated, or the costs of the environmental attributes are estimated.

According to the EUROSTAT classification, environmental costs are categorised relating them to 9 main environmental areas:

1. Water protection
2. Air protection
3. Landscape protection
4. Waste management
5. Soil protection
6. Areas reclaiming (cleaning up polluted areas)
7. Noise reduction
8. Research and development
9. Other activities

The environmental costs are subdivided in operational and capital costs, and are collected at operational level (drilling and production units) and thereafter aggregated at corporate level.

Because of the distribution of decision making authority, this case study is focused on two different subjects of the decision making process at unit and corporate level:

1. how waste management costs influence the choice of raw materials,
2. how decommissioning costs (the costs of dismantling oil platforms) influence investment choices.

5.1 Waste management costs influencing choice of raw materials

The costs of proper disposal of the drilling fluid have increased in recent years, due to more stringent legislation. (Drilling fluids are used to lubricate the drill and transport the drilling cuttings. The drilling fluid is filtered and reused several times, before it has to be disposed of in the form of a sort of mud.) The disposal fees depend on the quantity and degree of toxicity of the waste drilling fluid or mud. Agip is trying to reduce these costs by using alternative raw materials for composing the drilling fluid. Decisions on the composition of the fluid are taken at Item-level (at the individual drilling sites). Waste disposal costs are recorded in both the budget and the accounting ledgers at drilling site level.

The life cycle costs of the fluid are of interest. These are dependant on the price of the fluid used, on the quantity of fluid necessary per unit of drilling, and on the disposal costs (that are dependant on the toxicity of the fluid).

The corporate department for drilling has provided the operating units with some management tools that allow to include environmental considerations in the raw materials decision making process. These tools are indicators that correlate drilling fluid and solid waste. Each drilling well develops these indicators. The corporate department aggregates these data for each geographical district. The annual presentation of a document where these indicators are compared, motivates geographical districts to improve their own performances.

An example is the improved drilling fluid that was developed at the Montestillo Drilling Well. They found a new fluid that with an increase in costs of the mud of 8.4%, shows a reduction of solid waste produced of 14%, and a reduction of drilling time of 56%!

The discovery of improvements like this is made possible by the high degree of disaggregation of costs in the accounting system (at site level), and the decentralised decision responsibility.

5.2 Decommissioning costs influencing investment choices

The feasibility study that proceeds development of a new drilling site, includes capital costs, operating costs, and the positive cash flow due to the sale of hydrocarbons. Included in the operating costs are the so-called decommissioning costs: the costs of dis-

mantling the plant after profitable exploitation has ended. Usually these costs amount to about 10% of the total investment. In fact this is a cradle to grave analysis, a Life Cycle Analysis, analyzing everything from engineering, construction, operation to removal and disposal of the plants. The decommissioning costs may depend to a considerable degree on the initial design of the rig.

For comparing different design options for the oil rig, Agip uses Net Present Value and Internal Rate of Return. The time value of money is thus taken into account. This also means that the decommissioning costs, that fall at the very end of the investment period, have relatively little influence on the overall profitability.

A problem is estimating the decommissioning costs. These costs have been included in the feasibility-studies for 10 years already, but there is only a little experience with the actual costs of decommissioning. To solve this problem, a model has been developed. Input in this model are variables like sea depth, number of conductor piles, number of legs and weight.

However, this model is based on disposal of the plants on land. The model will produce wrong results if parts of the structure can be re-used in other drilling sites. If re-use is already anticipated in design of the structure, costs may be even further reduced.

Because Agip has implemented the Oil and Gas Sector Accepted Principles, the decommissioning costs are estimated and accrued in each year of occurrence to a special fund called 'Abandonment costs'.

Abandonment costs include all costs which according to law, contract or oil industry practice at the end of the production activities have to be paid by the company for abandonment of the area, dismantlement (taking old structures apart), removing of the facilities and the restoration of the site. The abandonment fund is determined for each item (=site, rig), even though in the Agip Balance Sheet there is only one comprehensive abandonment fund.

6 *Conclusions*

The accounting system and the decision making process have a number of strengths and weaknesses.

Strengths:

1. The system is comprehensive: many traditional and identifiable costs are recorded.
2. Most pooling of costs is done at the lower levels of the organisation, namely at drilling site level. This enables good insight in disaggregated accounting data.
3. Due to the high level of disaggregation, costs that are generally described as hidden costs, can here be considered as direct costs.
4. Also due to the cost pooling at site level, the managers of the site have good insight in the costs for which they are responsible in this decentralised organisation.

5. Agip is implementing a separate environmental accounting system, the Environmental Balance Sheet.
6. Environmental costs are traced to Environmental Management Areas. This could prove useful for control of investments.
7. The feasibility study includes the decommissioning costs.
8. Provisions are made for the decommissioning costs by means of an 'abandonment costs' fund.

Weaknesses:

1. Agip uses the rather limited definition of environmental costs of SERIEE. This could mean an under-estimation of future liability costs and of the less tangible costs. These less tangible costs, like the costs Shell experienced with the Brent Spar case, can be considerable.
2. In the environmental accounting system of Agip, only environmental costs are recorded. The related environmental benefits are left out.
3. The decommissioning costs in the cash flow analysis of a new project are regarded as fixed. In reality these costs could vary with different designs.

4.2.4 Identification of environmental costs at Cartiera Favini SPA

Stefania Borghini

1 Description of the company and its environmental effects

1.1 Description of the company

Cartiera Favini SPA was founded in 1736 [when the Republic of Venice authorised the conversion of a water-mill into a paper factory]. Now the Favini group employs 240 people, distributed over 4 companies. This paper focuses on one of the four, Cartiera SPA, employing 140 people. Cartiera Favini produces and sells paper and special cards of which it exports 45%.

Favini is a relatively small paper factory and has chosen to produce for niche markets, in particular products with a green image, and special features according to client demands. Only in this way it is possible for Favini to gain some competitive advantages, because the level of production does not allow to reach economies of scale and low prices. They seem to succeed in this because the rate of return on investment at Favini has been considerably better then the average for the Italian paper industry.

For Favini the environmentally friendly products are an important way of differentiating from the bigger companies, and a special range of products has been developed. In this range we find chlorine free paper, paper made of corn, paper made of algae, and paper made of residues of the orange juice and sugar industry. Apart from these ecological products, there is also a number of papers types made of the usual wood fibres. Because of Favini's dependence on the market niche for these ecological products, maintaining and protecting its green image is of special importance. Favini is very aware of the protection of its green image. A slogan at Favini's is: 'it takes ten years to reach a green image, but only one day to lose it'.

The three main levels of the organisational structure of Cartiera Favini are:
1. Managing Director
2. Production Manager, Installations Chief and the Commercial Director,
3. Planning Manager, Plant Factory Chief, Laboratory Chief.

In the holding company (Favini sr) other corporate functions are situated, such as Controlling Manager, Administration and Financial Manager.

There is an Environmental Group in which take part the Managing Director, Production Manager, Planning Manager, Installations Chief and the Laboratory Chief. In order to maximise integration between production management and environmental management, there is no special environmental manager.

There are two paper machines, using a variety of raw material. Raw materials include cellulose, flour of natural materials, CaCO3, starch, recycled paper, paper rests from other Favini factories, recycled paper, and water. In the process some additives are added, and so-called 'white water' containing residual fibres and filler, is pressed out and partly recycled into the paper. The excess white water from the smaller paper machine is cleaned through an osmosis process, and the water is reused. The white water from the other machine is sent to the wastewater treatment plant. At the end remains a kind of mud, consisting of water, filler and fibres. This is dried and partly used for making cardboard, and the rest is sent to a landfill.

1.2 Environmental effects

The main environmental issues of the paper industry are consumption of clean water, energy, cellulose (forest), discharge of polluted water, air pollution, and solid waste.

Two methods can be used to evaluate the environmental effects: Environmental Balance Sheet and the Life Cycle Analysis (LCA). The balance sheet comprises only the environmental effects related directly to the factory production, while the LCA includes effects before and after production.

The large production of mud (10 kilos of mud for every kilo of paper produced) is a major environmental problem. It is being tried resolved by reusing the mud for making cardboard.

The other main environmental problem, the consumption of trees, is being reduced by using alternative less harmful fibres, such as algae and vegetable waste.

2 Environmental management

The environmental policy of Favini has evolved from just complying to regulations, to producing green products and to marketing itself as 'the green paper company'. Now the whole production cycle is screened for environmental effects, and the green image is considered essential for keeping Favini's market niche. According to Favini, pollution is a synonym for economic loss.

Favini uses the following tools for environmental management:

- Environmental Manual: contains guidelines for the organisation of environmental management and investment and quality. This manual is required for EMAS approval.
- Environmental Programme: contains a number of environmental goals, that resulted from an environmental audit.
- Environmental Balance Sheet: this describes the flows of material, water and energy going in and out of the factory. The document is used both internally for decision making, and externally for communication with stakeholders.

- Life Cycle Analysis: this analysis assesses the environmental effects of all stages in the life of the products. The LCA has mainly been used for identifying environmentally less harmful raw materials, such as the fibres from algae.
- Environmental Accounting Reports: Besides the usual accounting reports, Favini annually develops:
- an accounting report of 'environmental protection action costs': this is the document that classifies environmental costs for the different environmental management areas: Air and Climate Protection, Water protection, Waste Management, Noise abatement, Natural Resources protection, Environmental R&D.
- an accounting report of characteristic activities environmental costs: this is the Environmental Chart of Account, which includes all the environmental costs classified in Labour costs, Raw Materials, Industrial Expenses, Environmental Marketing, Overhead, and Depreciations.
- Environmental Report: this is a comprehensive document that is exclusively meant for external communication. It contains a description of the company, of the environmental policy and management system, environmental effects (both the physical effects and the monetary expenses), and compliance with regulations.

3 Management accounting

Favini has a relatively detailed registration of the initial data for accounting. Most traditional environmental costs are recorded in some part of the accounting system. Apart from the usual accounting books, the following records are kept:

- Raw Material Register
- Product Sheets (raw material used, good for sales production, and lost material)
- Daily Production Process Description (a record of everything that is done with the paper machines)
- Average Sales Price
- Waste Register (legally required register of all waste movement).

Cost allocation is done either by allocating directly to products, or by first allocating to the two paper machines and then to products. The initially detailed registration of environmental costs is largely lost in this pooling and allocation process. This results in misleading signals in product costs. For example, some environmental costs like depreciation on pollution-control equipment, are added to common pools and then allocated to products, regardless of whether the products required these costs or not. Another example is the white water cleaning for the smaller paper machine. This machine does not need the wastewater treatment plant because it has the osmosis cleaning device, but yet the costs are spread to both machines and thus to all products.

Favini uses a Quality Costs System to monitor the costs of quality and look for ways of reducing these costs and increasing quality. This Quality Costs System has similarities with environmental accounting because the costs of non-quality partly include environmental costs.

There are four categories of quality costs:
1. Prevention costs: all costs of controlling quality, prevention of flaws in the product or production process, audits, etc.
2. Appraisal Costs: costs of supervising that things are made as they should.
3. Internal failure: costs of no quality before sale, like scraps, reworking, production stops.
4. External failure: costs of failures after sale, like customer returns, treatment of complaints, and warranties.

4 Problem definition

At Favini's environmental costs in present accounting system are not recorded separately, and thus difficult to see for the managers deciding on matters that have environmental effects. This regards both product pricing and investment decisions.

5 Response: making cost systematically clear

5.1 Environmental Accounting

A first step towards environmental accounting at Favini's is the identification of environmentally relevant cost centres. Favini differentiates between environmental expenses and environmental investments. The latter are the assets that are recorded in the Balance Sheet. Environmental expenses and investments are defined as costs made to avoid, supervise or eliminate pollution or consumption of natural heritage.

The following environmental cost pools were made and collected in an Environmental Chart of Accounts:
- Ecological Raw Materials
- Labour costs
- Industrial expenses
- Environmental marketing
- General expenses
- Depreciation
- Environmental plants
- Patents.

Each of these pools are subdivided into more specific environmental accounts.

Each of these cost pools were then distributed over the following environmental activities:
1. Prevention
2. Monitoring
3. Treatment and disposal
4. Conservation of natural resources.

Here the similarity between the Quality cost system and the Environmental Accounting becomes clear: these four environmental activities relate to the four categories of costs of

quality described earlier: Prevention costs, Appraisal Costs, Internal failure and External failure. In fact, an integration of the quality and environmental management system could be an efficient solution.

Remarkable is that both the Quality cost system and the environmental management system are developed by the production manager and the laboratory chief, and not by the accountant/controller.

5.2 Environmental Investments Decision-making

In accordance with the EPA approach, environmental investments are classified as must-do compliance investments, market expanding investments and cost saving investments. Investments proposal are judged by various managers on feasibility, environmental effects, technical efficiency, and financial aspects. Environmental investment proposals are different from the others in that many unquantified factors are taken into consideration.

Investment decisions are based on two criteria: the total amount of the investment, and the pay-back period. The pay-back period is calculated as the time needed to generate enough cash-flow (annual benefits minus operating costs) to just cover the initial outlay for the investment. The time value of money (discount rate) is not taken into account, so this method could be classified as 'quick and dirty'.

The investment in a water reuse plant for the smaller paper machine is the example that was chosen for the evaluation of the environmental investment justification process.

Quantifiable environmental benefits were the expected savings on water tax. Improvement of image quality was an unquantifiable environmental benefit, but nevertheless it was considered to be a very important one. In the decision on this investment not all costs that in a Total Cost Assessment (TCA) would have been taken into account, were considered by Favini. The costs of monitoring are an example of this.

The investment in the mud dryer plant was exclusively done for the image benefits, such as the possibility to claim a completely closed production cycle.

What Favini needs is not so much to use more information in the decision making process, but to organise this information in a more coherent way. A TCA is a good way of achieving this, especially if this is combined with the instruments already used: Environmental Balance Sheet and Life Cycle Assessment.

An analysis with both the TCA and the usual evaluation method of Favini has been made of the investment in the Micronising Mill Project. The micronising mill is a plant for grinding the alternative fibre raw materials in order to make them ready for use, and to improve the workers environment.

The comparison between the two methods shows that the TCA includes more cost categories and that they are more in quantified form. Favini used to take most of the less tangible and non quantified costs into consideration, but with the TCA all effects of the in-

vestment are taken into account in a systematic standardised form. This can be expected to accelerate and improve the process of investment evaluation.

Finally the combination of the TCA with the LCA, and with the Environmental Balance Sheet is evaluated. It is concluded that TCA and LCA supplement each other, and that an integration between the two would be recommendable. The Environmental Balance Sheet is also supplemental to the TCA, but also to the Environmental Accounting System. The Environmental Balance Sheet and the Environmental Accounting System provides the data to set the right targets, while the TCA and the LCA indicate which investments are best to achieve these targets.

6 *Conclusions*

Favini has a fairly well developed environmental accounting system because they record many environmental data in the various records, and because they use the Quality Costs System.

The decision on new raw materials is supported by a LCA, and also in other environmental investments decisions many environmental costs are taken into account, although partly in qualitative form.

A problem in the Favini product pricing is that many of the environmental costs are treated as overhead costs. Consequently, the product prices do not correctly reflect the costs that are made for the individual products. This practice is probably raising the actual price of the green products.

Favini uses a limited definition of environmental costs: costs of actions that are deliberately and principally undertaken to prevent, control, reduce or eliminate negative effects on the environment. Excluded are costs due to fines for non-compliance, liabilities because of environmental damage and future costs of environmental liabilities.

The quantitative expressions of environmental benefits are already recorded in the Environmental Balance Sheet. Using these for investment decisions could improve both the decision making process and the motivation of the production managers.

4.3 Company-based experience in eco-management accounting: four case studies in the Netherlands

4.3.1 Environmental accounting at Meerssen papier

Stefan Verdonschot
Michiel Wind

Description of the company and its environmental effects

The production of paper in the village of Meerssen in the south of the Netherlands has a long standing tradition, going back to as far as the fourteenth century. In the beginning a water mill was used for power, later this was replaced by steam-engines. After World War II, the company was forced to merge with other paper companies in the Netherlands in order to remain competitive. Since 1990 Meerssen papier is part of the Gelderse Papiergroep, which in turn is owned for 70% by the KNP BT concern. In 1997 the factory employed some 400 people and had a turnover of 136 million Dutch Guilders.

Regarding the market that Meerssen serves, emphasis is on production of specialties and sales to traders. A new market is thought to be small offices and home offices. Also in the use of paper for packaging Meerssen sees opportunities. An important factor in the markets are the environmental regulations, such as different kinds of environmental certificates like Blaue Engel and Total Chlorine Free.

Organisational structure:

Meerssen has a centralised structure, consisting of seven departments:
1. Logistics and Planning (including Purchasing)
2. Sales
3. Production:
   - preparation of fibres and paper machines
   - post-processing and finishing
4. Development and Quality
5. Personal and Organisation
6. Administration (including Computing and Automation)
7. Technical services.

The main steps in the batch-wise production process are:

A. Pre-process (production of raw paper):
   - input of the cellulose fibres
   - preparation process: fibre are mixed with water, colour and other additives, fibres are ground to the correct length.

- paper machines: the pulp (mainly fibres and water) is mixed with still other chemicals and dried on a strainer using vacuum and heat.

B. Post-process (refining of the raw paper):
- post-processing: in this phase the paper may undergo polishing, cutting in the ordered sizes, gluing, and embossing of certain profiles on the surface of the paper.
- packaging and expedition: the paper is checked for quality, packaged and sent to the customer.

Meerssen Papier's product range consists of a large number of paper qualities in thousands of different colours. The recipes for these are managed in a computer programme called Recipe Information System (RIS). The RIS is also used for automated calculation the total cost of the ingredients in every different product. As the RIS has all the exact quantities, this part of cost calculation is very precise.

In the process of paper production a lot of water is used. This is pumped up from ground water. Previously, after use in the production process this water was discharged directly into a small river. Nowadays the water is rinsed in a special plant. However, the disposed process water is not only an environmental problem, it is also a financial problem because valuable raw materials (mainly fibres and colours) are lost with the process water. This loss has now been reduced by a pre-rinsing plant which enables the reuse of process water within the same batch, and which also reuses part of the fibres. Increased use of these plants is under consideration by management.

A similar loss of materials is the so-called 'cassé'. Cassé is paper that is lost due to cutting and failures in the production process. The greater part of total paper production that is lost as cassé is being reused. Increased reuse is under investigation by Meerssen management.

2 *Environmental management*

In 1996 a voluntary agreement on environmental policy was reached between the Dutch government and the Dutch paper and cardboard industry. For a number of polluting substances, reduction targets were agreed upon. Meerssen is now implementing the agreement by analysing and changing its production processes and altering these were necessary. Also Meerssen wants to differentiate its products between more and less environmentally harmful, and they want these differences to be reflected in the cost prices of the products. The voluntary agreement also prescribes a reduction of ground water pumped up.

Another environmental effect relevant to the whole Dutch paper industry, is the use of cellulose that is made of wood for which valuable forest needs to be exploited. In another voluntary agreement that is expected to be signed soon, the so-called 'fibre agreement', targets for the recycling of used paper are included.

Electricity consumption is substantial, and this too has environmental effects which have been investigated in a separate study. The results have been used in the calculation of the environmental costs.

3 Management accounting

Correct calculation of cost prices is important for a number of reasons:

- the possibility to distinguish between profitable and less profitable products,
- charge customers with a correct price,
- distinguish between products that can be produced cheaper than competitors can, and production that is better left to other producers,
- correct cost information is necessary in good evaluations of investment decisions; wrong information may lead to bad investments.

The cost price of net saleable product consists of:

I. direct product costs
   - raw material costs
   - costs of colours

II. indirect product costs
   - costs of capacity
     - fixed
     - variable
   - post-processing costs and final process costs (which vary according to type)

Cost calculation of the pulp and paper phase (called pre-process phase) which includes the running of the paper machines, resembles a Process Costing system (Drury, 1992). This system is suitable for production processes where all products are more or less the same. Costs are allocated on the basis of number of used machine hours or produced quantity of paper. Which of these two is chosen is rather arbitrary.

Cost calculation of the post-process (the refining of the raw paper) follows the Job Costing System (Drury, 1992). In this system costs are allocated on the basis of the number and actual costs of operations applied to the product. The Job Costing System resembles activity-based costing (ABC), but only on a 'unit level'. Unit level means that the costs are allocated to units of product.

When the price for the customer is calculated, economies of scale are only marginally taken into account. The same goes for environmental costs, which are not shared over the products on the basis of the quantity of costs that a product actually generates. All overhead costs, including most environmental costs, are allocated to the pre-process, with machine hours and/or quantity of paper produced as cost drivers.

The RIS, the computer system that holds all recipes, is also involved in the automated calculation of the cost price of orders. The RIS holds the exact quantities of raw materials

that are necessary for a certain kind of paper. RIS calculates the costs of all ingredients by multiplying these quantities by the cost prices of the ingredients, based on the production of 1000 kilograms of the paper. The recycling of 'cassé' (the material that normally would be rejected and go to waste in the process) is taken into account in the calculation of the cost price. The use of cassé also has implications for the quantities of colour required because the cassé already has colour in it. This too is corrected in the calculation of the cost price by the RIS.

Summarising

Concerning the direct costs:

- calculated on the basis of the quantities of fibres, colours and additives needed according to the recipe in the RIS.

Concerning the indirect costs:

a. In the pre-process as cost drivers are used: number of machine hours, number of 1000 kilos paper produced, and/or number of paper rolls or sheets produced.
b. In the post-process the ABC system is used, as costs are calculated on the basis of the jobs (processes) that a batch undergoes.

4 Problem definition

The central question that this research was to answer is: how should the present management accounting system and cost price calculation system be adjusted so as to solve the needs of environmental management?

As environmental management becomes more important, the need to monitor, control and evaluate the costs related to environmental management grows. The cost accounting system needs to be adapted to the need for financial information related to environmental management. The resulting system could be called environmental accounting system.

Meerssen Papier's main environmental goal is to comply with present and future government demands regarding environmental protection. The present accounting system does not support management in this regard. Identification and correct allocation of all environmental costs and benefits to products is the goal of adjusting the accounting system. The ABC method seems to be the most suitable one for this.

5 Response: Activity-based costing

Activity-based costing collects, reports and allocates, as directly as possible, costs to the activities that cause the costs. This method shows the costs, including environmental costs, that are made for those specific activities or products.

Two approaches are possible:

a. Environmental costs can be allocated directly to activities; in this way environmental costs remain hidden in the other costs;
b. Environmental costs can be allocated to special environmental cost pools, and from there, with suitable cost drivers, to the various products; in this way environmental costs are both made visible and allocated correctly to the products that cause them.

The cost price of products consists of direct and indirect costs. Direct costs are costs that correlate directly with the quantity produced. Indirect costs have no clear correlation to the production volume and have to be allocated to the products indirectly. It may also be decided to treat costs as indirect costs, if a detailed breakdown of costs involves heavy expenses. Whether costs are treated as direct or indirect costs is often arbitrary.

The ABC method distinguishes between four levels of cost-causing activities, each with different cost drivers:

a. unit level activities: cost vary with the number units of products (for example kilograms of paper) processed.
b. batch level activities: costs vary with the number of batches processed.
c. product level activities: costs vary with the number of products in the range of products; an example are the promotional costs for introducing a certain new product; these costs are independent of the number of products sold or batches produced;
d. facility level activities: examples are the costs of services like administration and cleaning of buildings.

At Meerssen, the batch level costs are specially important. For a small batch these costs are relatively high. In the old system they are treated as overhead costs and are allocated to all products as percentages of the direct costs, thus leaving small batches with a too low price, and possibly generating losses to the company. In other words, economies of scale are ignored.

For setting up a cost accounting system based on ABC at Meerssen the following steps were taken:

I. Firstly, the composition of overheads, direct and indirect costs was determined. The direct costs of raw materials and colours have been kept out of this analyses, because the Recipe Information System calculates and allocates these in a precise and correct way.

II. Next, an overview of the activities was made. The activities were grouped in 4 categories, depending on what sort of cost driver they use: unit, batch, product or facility. Separate activities were identified for environment related activities, so that for example activities using recycled water instead of new water got their own (different) costs.

III. In this step a connection between the activities (step II) and their costs (step I) was made. The costs had to be divided over the activities with the help of rather extensive

studies in order to find out what proportion of the annual costs should be attributed to every activity cost-pool. This is phase 1 in the two-stage allocation process.

IV. Finally, cost drivers were determined that allocate the costs of the activity that a product uses. A cost driver is the unit of the activity or the parameter that mainly determines (correlates best with) the costs spent on an activity. For example, a good cost driver for the activity 'packaging of pallets' is the number of pallets. Multiplying the number of pallets in one order with the costs of packaging one pallet, results in the costs for the whole order. (If this activity was treated as overhead costs, all customers would pay a fixed percentage of the direct costs, regardless of whether they had their pallets packaged or not.) This step is phase two of the two-stage allocation process.

Step IV results in a table that calculates the tariffs per unit of activity. These tariffs can be used for calculating the correct cost price for every order and customer. This is simply a matter of multiplying the number of cost driver units with the number of activities that an order requires, and adding all these costs. The table is built up as follows:

Activities	Cost drivers	Usage/year	Cost-pool	Tariff/unit
	a	b = total of a	c = total annual costs	d = c/b
Unit-level				
Batch-level				
- packaging pallets	pallets	62,827	DFL 2,469,225	DFL 39.30
Product-level				
Facility-level				

If the Tariff/unit is used in the calculation of cost prices, this should be a correct measure of the actually generated costs. The environmental costs that following the ABC analysis can be allocated better are:

- The costs of the activity 'thinning' may be done with new water or with recycled water. Using recycled water costs DFL 0.04 and new water DFL 0.20 per cubic meter of water.
- The activity 'grinding' (the mixing of fibres and water) costs DFL 6.86 per 100 kg of fibres when cassé is used, and only DFL 2.69 when new cellulose is used. This is caused by the higher electricity costs of using cassé instead of new fibres, and it shows that recycling is not necessarily beneficial. Whether choosing cassé is beneficial in spite of the higher costs of grinding, will show in a complete cost calculation, where the RIS also incorporates the lower material costs of choosing cassé instead of new fibre.
- The costs of the activity 'disposal of wastewater' are now allocated to products on the basis of kilogrammes of dry material flushed. Products (papers) that generate more waste material now carry more of these costs than they did in the old system.

- The costs of the activity 'recovery of cassé' are allocated to those batches/products that produce this cassé. Mark that the costs are not allocated to the products that use the cassé.
- The tariff for the activity 'polishing and resetting' has been calculated in two versions: for a single batch and for multiple batches combined. The second version is cheaper because it saves water. In this way these environmental costs can be allocated correctly to the products. If the environmentally less benign activity is chosen, the extra costs for the environment are visible and paid for in a correct way.

In order to visualise the difference in costs of environmentally more and less benign products, one should calculate total costs price using the more and less environmentally harmful versions. With the tariffs calculated in the table this is easy, even for the thousands of different products that Meerssen offers.

Furthermore, as the environmental costs are marked as separate activities, these could be added separately in the calculation of the cost price. After that, it is possible to calculate the percentage of environmental costs in different products, indicating the more and less environmentally harmful products. Using this method, it became visible that small batches cause more environment-related costs than large ones, and that coloured papers cause more costs than white papers. Environmental cost percentages ranged from 7.1 for white paper in one full batch, to 12.3 for coloured papers in part of a batch. Some other environment related costs, such as the use of cassé, are already allocated correctly to the products that cause them by the old system.

Differences in cost price for some categories of products calculated with the old and new system ranged from 0.6 % for white paper in one full batch, to 12,4% for coloured paper in part of a full batch.

6 Conclusions

- Coloured batches cause more environmental costs than white ones. These extra costs were not allocated correctly by the presently used accounting system: coloured paper was sold for a too low a price.
- Small orders and orders implying only part of a batch of 1200 kilos, cause relatively high (environmental) costs. This is a kind of economies of scale, that, though not big, was not detected and accounted correctly by the old system.
- The heavier papers cause more cassé and consequently cause more environment related costs. The existing accounting system only partly takes this into account.
- Complex orders cause extra costs, but these were already detected in the existing accounting system. The new system has, however, made these extra costs more precise.

In the (near) future Meerssen Papier is likely to be obliged to recycle used paper due to the voluntary agreement in this field between the sector and the environmental authorities. The costs associated with this change in inputs can easily be taken correctly into account in the new system by adding an activity on the level of 'unit', namely 'use of external cassé'.

In general, the present system serves it's purpose well. However, in the future stricter environmental requirements and increasing environmental costs, invite a more elaborated cost accounting. The ABC method is a good instrument for integrating environmental and management accounting policy. Activity-based costing might lead to activity-based management, including responsibility centres and bench marks for employees to monitor their performance.

Finally, it is not easy, and not always required either, to define environmental costs separately. Environmental costs, like any other costs, have to be managed and correctly allocated to the products and activities that cause them.

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4.3.2 Environmental costs at a chemical Company

Peter Saris
Foppe de Walle

1 Description of the company and its environmental effects

The company studied in this report is part of an international chemical company. Two production sites in the Netherlands are the subject of this study. The sites are denoted by M and Z.

Site M, with 215 employees, mainly produces resins made of mineral oil and wood. The resins are used for adhesive purposes like paint, tape, plasters and chewing gum. The site consists of two factories:

1. Hydro Carbon Resin factory (HCR),
2. Hydrogenation factory.

Furthermore at M there are departments for:

- Utilities,
- Material Handling and Warehousing,
- Application and Development Laboratory,
- Project Engineering,
- Process Engineering,
- Quality Control Laboratory,
- Maintenance.

At the M-site the main environmental issues are chemical waste and emissions to air of volatile organic compounds (VOCs).

Site Z employs about 240 people and produces resins as well, but also chemicals for paper production. The three main factories are:

1. PTD factory, producing additives for paper production
2. Resin factory
3. WSC factory, producing Water Solvable Cellulose products.

Other departments at Z are:

- Boiler house
- Water purification plant: this plant uses a biological cleaning method. Of the pollution removed, about 85% comes from the WSC factory
- Technical Services
- Laboratories for production and development purposes
- Offices.

At the Z-site the main environmental problem is the wastewater. Due to an increase in production and stricter regulations, the capacity of the water purification plant has become too small. A new process, Wet Air Oxidation, involving a considerable investment, is under consideration in order to solve this problem. This process reduces the quantity of organic material in the wastewater, it reduces the quantity of hazardous waste to be disposed of, and it produces heat that can help reduce energy consumption. Another major investment with important environmental issues is the construction of a pipeline for a chemical product. The pipeline will replace the risky transport by lorries, and reduce leakages as well.

Both sites work with fully continuous production processes. Neither of the plants produce much direct consumer goods: most products are semi-manufactured, and are used by other industries.

2 *Environmental management*

Each plant has an environmental co-ordinator who discusses environmental matters with management. At the European level of the corporation there is another environmental co-ordinator that supports the national sites in their environmental management. Conform corporate requirements, environmental reports are regularly sent to European and corporate headquarters. These reports mainly concern potential liabilities, progress on clean-up and emission reduction efforts, and a limited amount of environmental cost information.

Environmental costs at site M are now classified in:
- Capital Expenditures,
- Site Remediation Costs,
- Waste Disposal Costs and Taxes, and
- Current Operating Costs.

At the Z site, environmental costs are budgeted and accounted for in the following categories:
- Labour,
- Maintenance,
- Depreciation,
- Allocated costs from other cost centres,
- Energy,
- Other.

3 *Management accounting*

Both plants M and Z use the Cost Centre Method. A comprehensive management accounting system that includes environmental assessments does not exist at the company at the moment. On a quarterly basis the different categories of environmental efforts and their associated costs are reported to the headquarters. The SAP system is being introduced in the company; this system includes environmental categories.

4 Problem definition

Central research question is how the present management accounting system can be adapted in order to improve insight in costs and benefits of environmental measures. More specifically:

1. What should be defined as environmental costs at these two sites?
2. What is the level of these costs?
3. Where in the company (what activities) generate these costs?
4. How can environmental costs be managed better?

Environmental costs and benefits deserve more management attention for the following reasons:

- Environmental costs may be significantly reduced when considered carefully.
- Environmental costs may be hidden in overhead accounts or otherwise overlooked.
- Environmental benefits, for example by sale of waste, can be discovered.
- Improved environmental performance can result in benefits for workers safety, health, and quality of products.
- Better allocation of (environmental) costs may result in improved pricing policy and therefore in improved insight in profitability of products.
- Improved environmental performance of products may lead to a better image with customers, which in turn may lead to a competitive advantage.
- Correct accounting of environmental cost may facilitate certification.
- Better registration of environmental costs is often useful in negotiations with environmental authorities.
- Financial data on environmental measures are necessary for development of an environmental care system.

5 Response: questionnaire and Model for Environmental Costs

Firstly the question on the definition of environmental costs must be addressed. The definition chosen was that of the Dutch National Bureau of Statistics (CBS), but with an extension: Environmental costs are the extra costs compared to a situation in which environmental considerations do not play a role and where environmental levies and taxes do not exist. The extension is the inclusion of the extra costs of cleaner process-integrated technologies and the costs of measures that lead to financial benefits. These are not included in the CBS definition.

To find the level of environmental costs that fit to the definition, a questionnaire was held among managers, followed by in-person interviews. Special attention was paid to labour costs incurred for the environment, as it showed that labour costs were an important part of total environmental costs. In fact, labour costs were the main reason for the difference of about 60% between the environmental costs as registered by the company and as found by the questionnaire. The environmental costs according to the non-extended definition of the Central Bureau of Statistics are even lower.

The Model for Environmental Costs (MEC) is based on the central idea that preventive measures can reduce pollution cheaper and better than corrective (end-off-pipe) measures. Similar ideas have already been established in quality management, and the MEC was derived from the Quality Control Cost Model (Mogezomp, 1991, and Diependaal & De Walle, 1994).

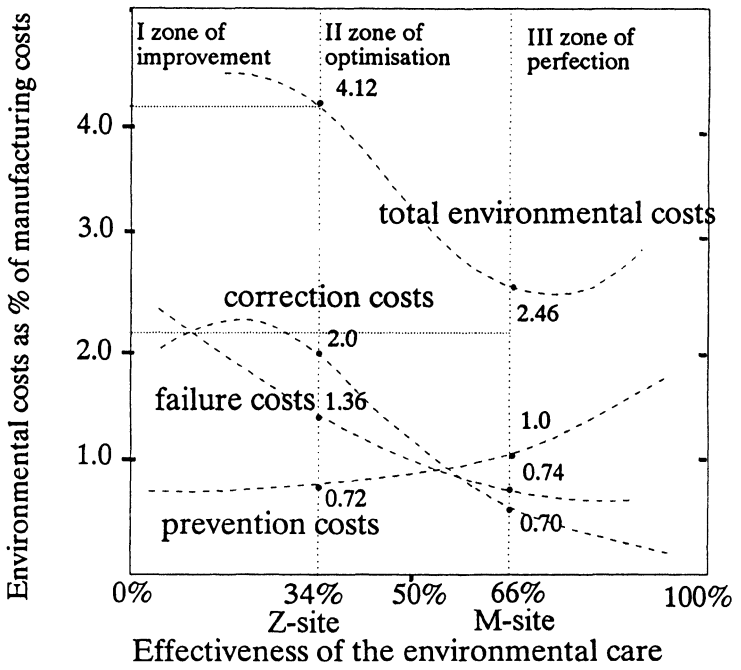
The Model for Environmental Costs makes a distinction between five costs categories:

1. Prevention costs: all costs incurred for the prevention of negative environmental effects.
2. Process integrated correction costs: all costs incurred to change the production process in order to reduce emissions or waste production.
3. Effect mitigating correction costs: all costs incurred for end-of-pipe type treatments of emissions, including costs of monitoring emissions.
4. Internal failure costs: all costs incurred for environmental restoration, ultimate disposal of waste and clean up of polluted sites inside the manufacturing plant boundaries.
5. External failure costs: all costs incurred for environmental restoration, ultimate disposal of waste and clean up of polluted sites outside the manufacturing plant boundaries.

According to the theory behind the MEC, the distribution of environmental costs over the five categories is related to the effectiveness of the environmental care system. Relatively high prevention costs (categories 1 and 2) indicate a well developed system, effectiveness and efficiency, because usually preventive measures are cheaper in the longer run. This implies that, given a fixed level of pollution, total environmental costs can be lower than in the opposite case: Relatively high correction and failure costs (categories 3, 4 and 5) indicate poor environmental management in earlier stages.

Using the MEC, the environmental costs within the company have been assessed, and categorised in the 5 categories. In figure 4.3.1 the categories are condensed to only three: prevention costs (1), correction costs (2 and 3) and failure costs (4 and 5).

Figure 4.3.1 Environmental costs at the Z-and M-site



Plant M seems to be closer to the optimal situation. With only lightly higher prevention costs (1.0% instead of 0.72% of manufacturing costs) total environmental costs at plant M are far lower (2.46% of manufacturing costs, versus plant Z 4.12%). Both plants are situated in the optimum zone.

Remarkable in the figure is that for plant M failure costs are higher than correction costs. According to theory this should be the other way around because one would expect companies to first clean up old pollution (failures), than to start with end-of-pipe measures (corrections), and finally to take preventive measures.

However, it should be remembered that these theoretical curves are just a general average. In individual companies specific conditions may differ from theory, for example because of the nature of specific production processes. Another complicating factor in testing the MEC is the fact that environmental costs overlap with costs made for quality, health and safety reasons, especially in chemical industry.

The accounting system is important for the last two research questions: Where in the company are environmental costs generated, and: How can environmental costs be managed better? At the moment SAP accounting system is introduced world-wide in the cor-

poration. The current system uses a batch-wise system, while SAP is a real-time computer system: data input is immediately processed.

Finally, an important finding is that labour costs associated with environment should be recorded as environmental costs because they are a dominant part of total environmental costs. But the ultimate aim should be to allocate all environmental costs, identified as such, to the products or processes that require the environmental measures.

6 Conclusions

Of the environmental costs according to the definition chosen in this study, about 40% is not taken into account as such. As a result, in management decisions that involve environmental issues these costs are not considered (correctly and precisely). Supplementing the accounting system with special cost centres for environmental costs could improve this. Making separate cost centres for environmental costs will also enable correct allocation of environmental costs to the products or processes that cause them.

Clear definitions and procedures to determine what part of an investment should be regarded as environmental are a prerequisite. The relation between environmental, health, safety and quality costs needs special attention. A universally accepted definition of environmental costs does not exist, but at least within one site and preferably within the corporation, definition should be uniform.

Special attention should also be paid to labour costs incurred for environmental reasons. Labour costs were the main factor causing the underestimation of environmental costs.

The curves of the MEC do not fit precisely to the situation at the two plants, as could be expected. The figures found suggest that in this company increasing prevention costs only result in lower failure cost after a relatively long lag period.

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4.3.3 Environmental costs at a furniture Company

Maurice van der Mark
Foppe de Walle

1 Description of the company and its environmental effects

The furniture company in this study is a well known supplier of bedroom furniture. In 1995 the company had a turnover of 95 million Dutch Guilders and employed 400 people. The products are sold to countries all over the world, and the company has sales offices in several European countries.

The company is organised in the following departments:

1. Production:
   - Bed furniture
     - Steel products sector
     - Wood products sector
   - Mattresses and Textiles sector
2. Logistics and Quality
3. Finance and Economics
4. Export
5. Sales
6. Facilities and Services

Situated between two residential quarters and nearby a school, authorities have imposed strict regulations on emissions from the company. The main environmental problem is the emission of Volatile Organic Compounds (VOCs), which are dangerous to health, cause smog and smell. The VOCs are released during the use of paints and glues in the production process. In 1987 230 tons of VOCs were emitted. Regulations require a reduction down to 100 tons by the year 1996, and 72 tons by the year 2000.

Besides VOC emissions, the production of fluid and solid wastes, both hazardous and non-hazardous, causes environmental problems. In the Steel sector of production, these environmental effects are related to welding, cleaning and painting of the steel. In the Wood sector similar environmental problems exist, including sandpapering of painted wood. This leads to dust containing paint particles, and this has to be treated as hazardous waste.

2 Environmental management

Until now, environmental management has mainly involved complying to the regulations that are imposed by authorities. Records are kept of the quantity of wastes produced, but not of the specific costs and other financial data related to environmental matters. There

has been no systematic environmental management until now, but an environmental care system is under development, as required by government. This system is expected to improve coherence, effectiveness and efficiency of environmental management, because it will lead to integration of environmental care in general management.

Having an environmental care system according to government guidelines also improves the relationship with the authorities. This may result in less strict control of environmental management, more freedom for company management, and thus in cheaper and more effective environmental care.

Several individual environmental measures have been taken. Examples are the use of High Solid paints, which contain less solvents (VOCs), and the introduction of special re-usable bags for packaging products. In the Wood Sector a special painting plant has been installed, using ultra violet light to dry the paint and thus again avoiding use of solvents.

3 Management accounting

The company has a regular management accounting system that regularly provides information like costs, incomes, personal resources information and throughput, but not yet structured environmental information. As a result of the technological and problem solving approach, systematic attention for corporate environmental policy or the financial aspects of environmental measures is less developed. The current environmental accounting system is limited to monitoring and controlling the movement of physical quantities of wastes, while there is hardly any financial information developed.

4 Problem definition

The financial information on environmental matters, that now is quite incomplete, is important to:

- investment decisions,
- discovering cost reduction possibilities,
- decisions on the composition of the product range (elimination of production of loss-generating products),
- selecting the best (cost-effective) environmental measures,
- evaluate profitability of departments,
- choice of raw materials,
- discussions with environmental authorities.

Until now environmental costs were rather limited, but as these costs increase, and are expected to continue to increase, environmental accounting becomes more important. The research question is how to adapt the present accounting system to these demands.

5 Response: Model for Environmental Costs

5.1 Model for Environmental Costs

The Model for Environmental Costs (MEC) is based on the central idea that preventive measures can reduce pollution cheaper and better than corrective (end-off-pipe) measures. Similar ideas have already been established in quality management, and the MEC was derived from the Quality Control Cost Model (Mogezomp, 1991, and Diependaal & De Walle, 1994).

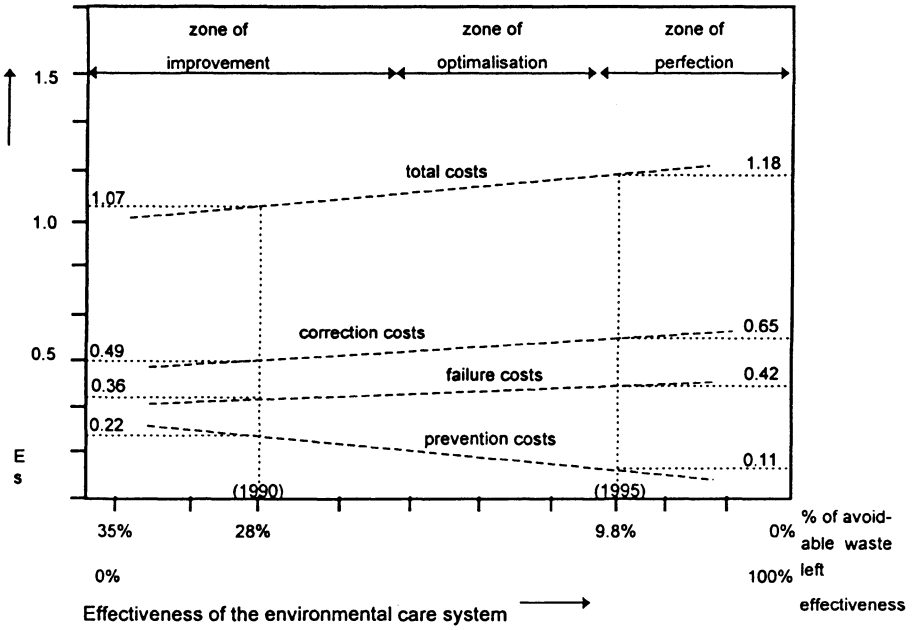
The Model for Environmental Costs makes a distinction between five costs categories:

1. Prevention costs: all costs incurred for the prevention of negative environmental effects.
2. Process integrated correction costs: all costs incurred to change the production process in order to reduce emissions or waste production.
3. Effect mitigating correction costs: all costs incurred for end-of-pipe type treatment of emissions, including costs of monitoring emissions.
4. Internal failure costs: all costs incurred for environmental restoration, ultimate disposal of waste and clean up of polluted sites **inside** the manufacturing plant boundaries.
5. External failure costs: all costs incurred for environmental restoration, ultimate disposal of waste and clean up of polluted sites **outside** the manufacturing plant boundaries.

According to the theory behind the MEC, the distribution of environmental costs over the five categories is related to the effectiveness of the environmental care system. Relatively high prevention costs (categories 1 and 2) indicate a well developed system, effectiveness and efficiency, because usually preventive measures are cheaper in the longer run. This implies that, given a fixed level of pollution, total environmental costs can be lower than in the opposite case: relatively high correction and failure costs (categories 3, 4 and 5) indicate poor environmental management in earlier stages.

Using the MEC, the environmental costs within the company have been assessed, and categorised in the 5 categories. This has been done for the Wood and the Steel sector, not for the whole company. These two sectors are the main polluters. As the present accounting system does not record environmental costs, the data were gathered by means of a questionnaire among managers. The analysis has been done both in 1990 and 1995 (figure 4.3.2).

Figure 4.3.2 MEC for Wood and Steel sectors in 1990 and 1995



As mentioned earlier, the distribution over the categories indicates how developed the environmental care system is. Three zones are distinguished:

I. Zone of improvement: Total environmental costs can be reduced by increasing the proportion of prevention costs, as this will be more than compensated by reduced correction and failure costs.
II. Zone of optimisation: In this zone the total environmental costs are as low as possible (provided compliance to regulations).
III. Zone of perfection: here environmental damage is still lower, but the increasing prevention costs are no longer compensated by reductions in correction and failure costs, and total environmental costs increase.

Summarising: the MEC suggest that there is an optimal distribution over the five cost categories, and that generally the more primitive environmental care systems have relatively high correction and failure costs, and the well developed, optimal systems more preventive measures. Too much emphasis on prevention however, as on correction, will make environmental management less cost-effective.

Figure 4.3.2 shows that in 1990, the company was in the zone of improvement. In 1995, in spite of a large reduction in the production of waste, the distribution over the five categories has changed only slightly. This does not comply with the theory behind the MEC.

5.2 Discussion

The small change in distribution over the five cost categories in spite of the considerable improvement in waste reduction, can be explained by several factors:

- In the study only two years have been examined. There are no data available on environmental expenses in the intermediate years. Maybe extensive (preventive) measures were taken in those years, yielding results in 1995.
- The reduction in waste could be the result of measures that are not included in the definition of environmental costs. It is known that the Wood and Steel Sections have invested considerably in quality improvement in the years 1990-1995. It is quite likely that this is a reason behind the reduction of waste. Unfortunately this could not be studied in this case due to a lack of data: quality cost are not recorded separately at the company.

5.3 Integration of the MEC into the management accounting system

There are three elements that should be considered if the management accounting system and the MEC are to be integrated in order to generate environmental data.

1. Definition of environmental costs:
   Currently there is no clear definition of environmental costs in the company. This is of course a prerequisite for measuring and accounting these costs. Present accounting system states that environmental cost in 1995 were 282,900 Dutch Guilders, but this is only 27% of the environmental costs according to the MEC in the same year.
2. Categorising of environmental costs:
   The present categories in the accounting system of the company do not include a separate category for environmental costs. Such categories should be installed.
3. Control of environmental costs:
   As there is no environmental care system, there are no targets for environmental management (apart from complying to regulations). Because there are no targets, there is no need to measure if the (financial, environmental) targets are met. Therefore there has not been any demand from management for financial information on environmental matters. Incorporating the MEC into the management accounting system should therefore be accompanied by development of an environmental care system.

6 Conclusions

Application of the MEC should preferably be combined with an analysis of quality management costs, because quality and environmental measures often overlap. Because environmental measures often also improve quality of the products and of health and safety, they are often more profitable than one might expect.

Concerning integration of MEC into the present accounting system, it is necessary:
- to define environmental costs,
- to install accounts for environmental costs in the present accounting system, and
- to develop an environmental care system with clear targets that are also translated in financial terms (budgets and accounting reports). The study shows that this is well possible, and that the accounting system will be able to take environmental costs and benefits into account in budgeting as well.

Furthermore, the MEC enables controlling environmental costs in two ways. Firstly, the distribution of costs over the five cost categories is and indication of whether the company is in the zone of improvement, optimisation or perfection. It must be noted however that it is only an indication. The indication can gain reliability when more data are available, such as on quality improvement measures and on more than just one or two years. Secondly, as environmental costs are better known, these can be used to analyse efficiency, cost-effectiveness or cost-benefit rate of different environmental measures.

Literature

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4.3.4 Environmental costs and the reuse of consumer replaceable units by Xerox in Venray

Marijn Baarda
Willem Huntink

1 Description of the company and its environmental effects

Xerox Limited manufactures and markets Xerox products across Europe, the Middle East and Africa. This wholly owned subsidiary of Xerox Corporation dates from 1956, when Xerox made its first foray into international markets with Rank Xerox, a joint venture with The Rank Organisation plc, the British leisure and entertainment conglomerate. Xerox gradually increased its stake and bought out Rank's interest entirely in 1997. Of the $ 18.2 billion Xerox sales revenues in 1997, Xerox Limited accounted for $ 5.5 billion. Xerox Ltd. employs approximately 19,000 people of a total of 91,000 Xerox employees world-wide.

In 1965 Xerox started a manufacturing operation in Venray, the Netherlands. Today, the activities of Xerox Venray (XV) include the assembly of mid-volume copiers and printers, customer replaceable units (CRUs), power supplies, the production of toner and developer and the distribution of machines, supplies and spare parts into the Xerox Ltd. markets from the European Logistics Centre. Xerox Venray employs more than 1,800 people.

In 1993 the structure of the Venray manufacturing organisation was realigned into so-called Business Centres (BC) focusing on specific activities:

- Systems Manufacturing BC: Assembly of light lens and digital copiers, printers
- Supplies Manufacturing Operations: Production of toner, developer and photoreceptor components
- Print Cartridge BC: Production of plastic components and assembly of CRUs
- Electronics BC: Production of power supplies and repair of electronic modules
- Asset Recovery Operations (ARO): Intake, stripping and repair of modules and components

Xerox has established a track record as an innovative company with regard to their environmental policy based on the 3-R strategy: Reduce, Reuse and Recycle. This waste free concept extends from pollution prevention, emission reduction and hazardous materials elimination to responsible resource consumption. All major Xerox manufacturing sites world-wide have been ISO 14001 certified.

The company recently adopted 'The Document Company, Xerox' as its corporate signature to reflect what is the business of Xerox: Document management. Xerox sells publishing systems, copiers, printers, scanners, fax machines and document management software and associated products and services.

2 Environmental management

Since the introduction of its first copiers, Xerox has recovered products and parts for re-use. it was recognised that the majority of the components and subsystems can be re-used several times whilst still meeting the original quality standards. Machines and supplies (including Customer Replaceable Units) which are removed from customer premises in Europe are returned to Asset Recovery Operations in Venray. Here they are dismantled for remanufacturing or for stripping parts for reuse. The Customer Replaceable Units (CRUs) are the main topic of this study.

CRUs are being collected from customers via the Xerox service organisation, pick-ups from so-called 'Eco boxes' or via a replied paid postage system. The overall CRU return rate in Europe of Venray produced CRUs is around 70%. A significant part of the remaining 30% of the CRUs in the field is disposed by the customers. A small part is collected by pirates or brokers for repair. The Xerox Operating companies throughout Europe receive a return fee for collecting and transporting CRUs to Asset Recovery Operations in Venray.

Depending on the quality of the returned CRU and the pre-defined inspection criteria, ARO determines whether the CRU can be used for remanufacturing or whether the CRU will be stripped for parts recovery and recycling. Subassemblies and parts are supplied to the CRU assembly line of the Print Cartridge BC. Independent on the history of the sub-assemblies or components (new or recovered) the CRU will leave the factory as a new product. Extensive qualification testing of components, products and processes guarantees that all CRUs fully meet new build print/copy quality and product life standards. Due to the fact that the production of remanufactured CRUs require more handling and labour time than new CRUs, the production costs are higher however material costs are lower. In Section 3 costs of the different types of CRUs are discussed in detail.

3 Management accounting

The reorganisation of manufacturing activities into Business Centres was accompanied by a modification of the accounting procedures. Before 1993, indirect activities associated such as buying, material management, quality assurance and environment were performed by central departments, and were not allocated to specific products or business centres, but administered and budgeted as overhead. However, since the reorganisation of the manufacturing activities in 1993, indirect costs are allocated to the individual Business Centres.

Obviously, budgeting and allocating indirect costs is an arbitrary procedure. Due to tighter regulations and a rise in costs of disposal, the annual budgets for disposal have been increasing for several years now. Therefore, Business Centres within Xerox Venray have started a discussion on whether the company should apply the principles of activity-based costing (ABC) in allocating costs of disposal. ABC would make it possible to specify activities such as removal and disposal which account for the overhead costs of disposal and

waste. However, until this moment XV management has not yet defined specific activities and actions to implement ABC at the Venray site.

Depending on the outcome of the categorisation at ARO a CRU can be used for remanufacturing, or for parts recovery and recycling. For both processes different financial methodologies are in place.

For remanufacturing the CRU is stripped to a certain level. This hulk is sold to Print Cartridge BC by ARO for an agreed price. The price depends on the effort that ARO has to do to recover the hulk. This is built into the cost of the remanufactured CRU.

For parts reprocessing another process is applied. The CRU gets stripped to the level of the individual piece parts, which are sold to the Print Cartridge BC for 95% of the standard cost of a new part. Both the buying and the financial policy within XV creates an incentive for Print Cartridge BC to buy parts from ARO instead of from external suppliers. According to the buying policy ARO is treated as preferred supplier if parts are being supplied both by an external supplier as well as by ARO. The financial transactions with ARO are done at 95% of the standard cost price of the piece part. ARO earns a profitable margin on their operations, which is allocated to the Print Cartridge BC. In XV terms this profit is called the ARO revenue. This revenue should be at least equal to the return cost of a CRU. This gives also the financial incentive to buy parts from ARO, rather then from the external supplier.

4 Problem definition

It is important to notice that the corporate take-back policy for CRUs is not only profitable from environmental point of view, but also from a financial point of view. The important issue for corporate concern is how to maximise the return rate of the take-back policy by creating an efficient management accounting framework that stimulates efficiency along the take-back and recycle chain within the XV organisation.

The decisions within the XV policy relate to the following questions:

- How can we increase the CRU return rate?
- How do we account for the costs and benefits of take-back policy?
- How do we reach alignment of corporate objectives regarding take-back policy and performance of individual business centers?
- How do we assess and allocate end-of-life costs of CRUs that can not be reused?

The production cost of a CRU is determined predominantly by the costs of parts and sub-assemblies obtained from internal and external suppliers. The *standard cost* of the parts are set on the external supplier quotes, added up with landing costs and material related overhead costs.

ARO calculates the *recovery costs* of the parts. The costs of ARO consists of handling, transport, direct labour and overheads, and environmental costs. For recovered parts all transactions between ARO and the Business Centres are done at 95% of the *standard*

costs. The difference between the recovery cost and the standard cost (profit) is allocated to the Business Center which receives the recovered parts.

However, there remain questions about the way these recovery of parts and subassemblies are calculated. More specific, the way environmental costs and benefits can be accounted for and put together into an efficient accounting framework is still unclear. In the next sections we will discuss the following three topics:

- Management accounting practice: Assessment of the standard work prices and the consequences for decisions regarding reuse of CRUs (section 5.1)
- Assessment of end-of-life costs of CRUs and the consequences for decisions concerning the production of CRUs (section 5.2)
- Assessment of the cost and benefits of take-back policy on corporate level versus Business Centre level (section 5.3).

5 *Response: analyses costs and benefits at various levels*

5.1 Standard work prices and reuse of CRUs

XV calculates the relative cost prices of the types of CRUs to be:

1. Remanufactured CRUs, consisting mainly of *used subassemblies*, and
2. New built CRUs, consisting of a mixture of *new built parts* and *reprocessed parts*. This mixture is based on economical and technical possibilities to reuse parts. A part is reprocessed if the costs of recovery is lower than the price of the part from the external supplier.

The cost price of a remanufactured CRU is lower than the cost price of a new built CRU.

5.2 End-of-life costs of CRUs and re-use of CRUs

The number of the CRUs to be disposed of as end-of-life return flow (because reuse or recycling is not possible anymore, given the quality standards or acceptable cost levels) determine the future costs of disposal. In order to quantify this end-of-life return flow, a model was constructed for planning the return flow of CRUs based on the life cycle costing method. This method can be defined as a decision-making framework that encompasses all revenues and costs associated with a product or service as it moves through the predictable the stages and phases of evolution. Two particular areas, which a number of organisations have started to examine, are the costs of dealing with emissions or wastes from equipment or of disposal of products at the end of their lives. In order to estimate the costs of disposal at the end of the product life, we have to make assumptions about the development of costs of disposal per unit over the product life cycle of copiers or printers.

In order to plan the expected number of CRUs that will have to be disposed of at the end of their life, we have to examine the product cycle of copiers / printers and make assumptions on the following three variables:

- Machines in the field (MIF): based on the assumption that the demand for copiers or printers will go through the four phases of a product life cycle: introduction, growth, maturity and decline.
- Average monthly print volume (AMPV): an assumption about the average monthly number of prints that are produced by a copier / printer.
- Lifetime of a CRU: lifetime in terms of the number of prints that can be processed by a single CRU.

Given the assumptions above, the CRU-demand in a certain month t, can be calculated as:

$CRU\text{-}demand_t = (MIF_t * AMPV) / CRU\text{-}lifetime$

This model, in combination with the bill of material of CRUs, enables the purchasing department of Print Cartridge BC to plan the amount of parts and subassemblies needed to meet the demand for CRUs. The extent to which this demand can be matched by the reuse of returned CRU depends on the quality and number of returned CRUs over the life cycle of the particular family of copiers / printers.

The period that a CRU is in the field ranges from a few months to a few years, depending on the type of machine and the usage by the customer. It was recorded that approximately 70% of the CRUs produced in Venray actually are being returned for reuse to the plant in Venray.

Given the recorded number of CRUs produced, the demand for copiers or printers over the stages of the product life cycle, the return rate of 70% and the time lag of a number of months, the number of CRUs that have to be disposed at the end of the product life cycle can be calculated as follows:

$CRU\text{-}scrap_{t=n} = f(CRUs\ in\ the\ field t_{t(1,n)}, CRU\text{-}time\ lag, CRU\ return\ rate)$

where:

- CRU-scrap = the total number of CRUs that have to be disposed
- CRUs in the field $_{t(1,n)}$ = the number of CRUs that were in the field over the whole life cycle of the copier or printer
- CRU-time lag in months
- CRU-return rate: currently 70%.

As a consequence of the gradual decline in the number of machines in the field at the end of the copier or printer life cycle and the return rate of 70%, the projected number of CRUs that have to be disposed of in the end of the product life cycle is not very high. However it is not exactly known what will be the future costs of disposal of each individual CRU.

Moreover, the life cycle analysis shows that the current internal pricing policy does not take into account these end-of-life costs. When we include the end-of-life costs in the current price of remanufactured CRUs, this has implications for the decisions concerning the production of CRUs.

From the perspective of Xerox company, this could lead to suboptimal decisions of individual business centres, because the corporation pays both for the new parts and for taking back used parts that have to be disposed of. In order to examine this theoretical possibility we will take a closer look at the take-back policy from a corporate point of view.

5.3 Cost and benefits of take-back policy

In this section we will examine the costs and benefits of the current take-back policy of Xerox from a corporate point of view.

On a corporate level costs of take-back policy can be broken down in the following categories:

- Cost of transportation. Direct (via prepaid mail) or indirect (via pick up organised by the operating companies) transportation from customers to ARO Venray.
- Cost of handling and storage.
- Cost of disposal. Costs associated with the disposal of CRUs and CRU parts that no longer can be re-used or recycled, in accordance to environmental regulations and company environmental policy.

The benefits of reuse of CRUs can be divided into the following categories:

- Material costs savings. Due to the reuse of subassemblies and parts returned to CRU production, the Print Cartridge BC will have to buy less relatively expensive materials and parts. Disassembly, cleaning and recovery of components however is labour intensive.
- Savings on disposal cost. As Xerox has obliged itself to take-back of used CRUs, it will have to pay for their disposal. Therefor, reusing CRUs instead of disposing of them implies saving of costs.

The case study shows that remanufacturing benefits in general is financially beneficial to Xerox at corporate level, because the cost price of a remanufactured CRU or CRU with recovered components is less than of a CRU containing new parts only. At Business Centre level, however, things can look differently. If ARO has to pay for the disposal of surplus returned CRUs and not recoverable parts, the ARO profit (that is being allocated to the Print Cartridge BC) will decline. This may lead to Print Cartridge BC buying more new parts from external suppliers because that is more beneficial to Print Cartridge BC. To overcome this potentially suboptimal behaviour, the researchers have suggested to consider the following option.

Because the cost to Xerox of disposal increase with increased use of parts instead of used parts, and according to the ABC principles, the costs of disposal of old CRUs should

be allocated to the purchase of new parts. This can be done by a levy that Print Cartridge BC pays for every new part they buy. The revenues of the levy should be used, perhaps via a fund, to pay for the costs of disposal of returned CRUs that are not used for re-manufacturing.

Instead of making the used parts cheaper, the levy would make the purchased new parts more expensive. In any way the use of used parts is stimulated, but the height of the levy is correlated to the actual costs of disposal and therefore provides a correct price incentive.

6 Conclusions

XV's operations include the operation of several management systems, including elaborate management accounting systems. These systems are used and can increasingly be used in support of the company's environmental management.

Recycling and remanufacturing of used parts is well developed in the company. The case study touched on the problem which is inherent in extensive recycling schemes, namely what happens when the old parts cannot be used anymore because of new designs taking over. For the CRUs the problem appeared very limited. However, in other cases the problem may be much bigger. The idea to include the end-of-life waste disposal costs in the cost price of new parts and rather than in the cost price of the returned old parts may also help to secure the financing of the end-of-life disposal. Then, each round of recycling can be seen as a postponement of the disposal for which finances are available. The case also shows the importance of considering the internal incentive structure associated with transfer pricing. In fact, this is a general problem, which, however, may gain in importance when considering the greening of industrial activities.

4.4 Company-based experience in eco-management accounting: four case studies in the UK and Ireland

4.4.1 Developing an environmental financial statement at Baxter International's Irish Manufacturing Operations facility

Martin Bennett
Peter James

1 Description of the company and its environmental effects

Baxter International is a leading producer, developer and distributor of medical products and technologies world-wide. It offers more than 200,000 products to health-care providers, with total revenues of around $5 billion per annum.

As well as the corporate centre, which includes the corporate environmental team, there are four product-based manufacturing divisions: Renal, Cardiovascular, Biotech, and Intravenous/Hospital. There is also a regional organisation for sales and marketing, which also provides support to manufacturing facilities.

At a corporate level, Baxter has a number of impacts on the environment, the main ones being emissions to water and air, use of energy and other natural resources, waste generation, and packaging. Baxter International started an environmental programme in 1976, and in 1990 made a commitment to go beyond compliance and develop a 'state of the art' environmental programme. An environmental affairs unit was set up at corporate level; in a large and decentralised company the role of corporate units like this is to encourage and facilitate, rather than to enforce initiatives at local level.

One of their initiatives was the creation of an Environmental Financial Statement (EFS). The EFS provides an annual overview of the aggregate amounts of environment-related costs and benefits across the corporation. The subject of this case study is the initiative taken by one of Baxter's production facilities, Irish Manufacturing Operations, to develop a similar EFS at facility level.

Irish Manufacturing Operations (BAXTER) employs about 900 people divided over two sites, some 20 miles apart. In recent years its production volumes have increased by an average annual rate of around 10%.

BAXTER's main environmental impacts are effluents and wastes, both hazardous and non-hazardous. Other high priorities are the minimisation of product packaging, and energy efficiency.

2 *Environmental management*

BAXTER has won several awards, both internal and external, for its environmental management. BAXTER was the first Baxter facility to reach the corporation's target of 100% achievement of its 'state-of-the-art' environmental standards, and has received other internal awards in recent years. In 1996 BAXTER achieved accreditation with IS 310, the Irish environmental management standard, and in 1997 achieved the ISO 14001 international certification.

As part of its environmental programme, the corporate environmental unit has since 1990 prepared an annual EFS, and published this externally in its Environmental Performance Report since 1992. The EFS can be seen as a periodic cost-benefit analysis of the environmental programme at the level of the corporation as a whole. Its emphasis is on the value generated for the corporation, rather than attempting to assess the value to society of the corporation's environmental performance. The aim is to illustrate that environmental costs are treated in the same way as any other costs incurred by the company: to be minimised as far as possible, and where possible to generate maximum financial benefit.

Its purpose is primarily to stimulate and improve discussion within the corporation, rather than to serve as a wholly rational decision support tool. One driver has been quality. In its environmental management, Baxter uses a total quality management (TQM) approach, one important aspect of which is measuring the impact of actions or lack of actions. Financial measurement is central to this because it may persuade sceptics who think that a good environmental programme is incompatible with good business.

There are further advantages of the EFS. It helps environmental staff to communicate with line managers in the same 'language' that they are used to, and thereby improves communication and credibility. It shows that environmental staff can be not merely a cost, but an investment that can contribute to profitability. The EFS provides direction for management by identifying future cost-saving opportunities.

After several years' successful experience with the EFS at a corporate level, the corporation was keen to 'cascade' down this approach to operational levels such as production facilities. BAXTER volunteered for this experiment since it provided an opportunity for them to reflect the success of their environmental management, and to provide direction and motivation for further activities.

Most annual environmental data collection for internal reporting is done in January when the annual report on the 'state of the environmental programme' is prepared for the corporate management. As much of the work involved in this report is the same as that required by the EFS, it was decided to do both at the same time.

3 *Management accounting*

BAXTER's financial reporting is General Ledger-based. They produce a range of regular performance reports, at different frequencies and to different reporting levels in the or-

ganisation. These reports include the calculation and reporting of variances against the budget, which is set in consultation with others in the corporation, including the Renal Division management to whom BAXTER reports and who are their main internal customers.

The main budget-setting processes are from May to October, when all the standard costs for production are reviewed in detail looking for potential savings, or 'Value Improvement Potential' (VIP's). Capital expenditures are budgeted as a part of the annual budgeting process, and in addition each proposed project is evaluated separately. The main methods of evaluation used are the pay-back time and net present value, with pre-set thresholds prescribed. However, exceptions to these standard thresholds can be made when a project represents 'good management practice', which may include environmental reasons.

As yet, environment-related costs, such as for waste disposal, are not routinely charged back to the processes which create them. Only the physical waste streams are tracked, as are all recycled materials. The costs associated with disposal are tracked and monitored only in total. BAXTER is looking at the feasibility of internally re-charging significant environment-related costs on the polluter-pays principle, with energy costs being the initial focus. BAXTER is also introducing activity-based costing in order to improve cost information and highlight saving opportunities.

4 Problem definition

The aim of the BAXTER EFS, as with the corporate EFS, was to identify environment-related costs and benefits, and to produce a single statement to report these, for use within the organisation.

The main problem which was anticipated was the effort which was likely to be involved in collecting, and converting into a suitable form, the available data. BAXTER keep detailed production and operational records, so they expected that most of the data would be already on hand. However it was uncertain whether this would be in the form required to prepare the EFS without substantial further analysis.

Another anticipated challenge was the correct application of the methods which had been used successfully in preparing the EFS at corporate level, to the preparation of a facility-level EFS. This related in particular to the calculation of the amount of cost avoidance arising from environmental initiatives taken in previous years.

5 Response: Composing the Environmental Financial Statement

A two-person project team was set up, comprising the environmental engineer (who was also responsible for collecting the data for the Report on the State of the Environmental Programme), and a financial officer.

BAXTER's 1996 EFS extends to 8 pages in total. The actual report of costs and benefits takes two pages (see Appendix). The remaining 6 pages show explanations of the bases

of the calculations and management commentary on the results. The BAXTER EFS follows as closely as possible the format and methods of the corporate EFS, with costs distinguished between the proactive programme, and remediation and waste disposal. Benefits include income, savings, and cost avoidance.

'Savings' are the difference between actual costs in the report year (1996), and actual costs in the previous year. This is therefore the absolute amount of any saving, irrespective of any changes in the underlying rates of business activity and prices. If, as in the case of Baxter, volumes of production and input prices tend to increase over time, this method of calculation, if used on its own, tends to under-estimate the true business benefits of environmental initiatives.

To address this, the concept of 'cost avoidance' was designed. This is calculated as the difference between the amount actually spent in the previous year, and the hypothetical amount that would have been spent in the current year if no action had been taken to improve the environmental performance (for example, if the quantity of waste per unit of product had been the same as last year). For this, the difference is calculated between (1) the actual amount incurred in the current year, and (2) the actual amount incurred in the previous year, multiplied by the average annual percentage increases in (i) production volumes, and (ii) the market prices being paid for the relevant resource.

In order to obtain the total benefit arising from the improvements generated by the environmental programme, the amounts of both savings and cost avoidance have to be added together.

Two different quantities are reported in respect of cost avoidance. Firstly, 'cost avoidance arising from report year's initiatives' measures the benefits realised in this year (1996) from initiatives introduced during the same year. However this alone would still underreflect the total benefits arising, since many improvements will incur a cost only at their inception, but will then generate benefits for several subsequent years. To measure this, 'cost avoidance in report year from efforts initiated in prior years' is calculated. In calculating this, only benefits arising from initiatives taken in 1993 or subsequently were taken into account, since 1993 was when the main environmental improvement programmes were started, and since when data has been available.

The EFS shows that total benefits arising from initiatives taken in 1996 represented 142% of the costs incurred in that year on the proactive part of the programme.

5.1 Costs

Environmental Personnel Costs (£52,036)

This is mainly the employment costs, including social costs, and other personnel-related costs such as for travel, of staff involved in the environmental programme. For those who

work for only a part of their time on environment-related activities, an appropriate portion of their employment costs is used.

Environmental Education (£4,025)

This refers to the continuing training and development in environmental matters of Baxter's own staff, and includes both direct training through seminars and training courses, and subscriptions to journals and written material.

Environmental Fees (£9,000)

This item represents the costs outlaid to external consultants for advice and information on new developments, for example in legislation, and for external environmental audits.
Pollution Controls: Operations and Maintenance (£24,900)

This is cost of operating and maintaining environment-related equipment such as for waste disposal, end-of-pipe effluent treatment and monitoring. It was decided not to include the costs of equipment such as air filters and carbon filters because these relate to health and safety as well as to environment.

Pollution Controls: Depreciation (£6,205)

This is the capital costs of the same equipment as under the previous item. The amounts are taken directly from the accounting ledgers and reflect the company's policy of writing off fixed assets such as these over lives of 11 years.

Environmental System - IS 310 (£10,000)

IS 310 is the Irish environmental management standard. This item is the outlaid costs incurred in connection with obtaining this accreditation, such as consultancy fees, preparation and printing of materials such as manuals, and additional equipment. It does not include any estimate of the cost of the time spent by BAXTER's own staff on this exercise.

Environmental Monitoring (£13,150)

This is the amount paid to the external contractors who carry out the periodic sampling of effluents and emissions to air.

Outreach Activities (£12,815)

Baxter has a policy of involvement in and support of the communities local to its facilities, for example through providing learning materials and, on occasion, the direct input of Baxter staff for the benefit of local schools. The amount is taken from the accounting ledgers and checked with the Human Resource Department who are primarily responsible for outreach activities.

Waste Disposal - Hazardous (£12,517)

This is the total costs incurred with external waste contractors for hazardous wastes sent off-site during 1996. The amount is taken from the ledgers in the first place, but an adjustment is made, since the cost is entered in the ledger only after the wastes have reached their final destination. Since this may take several weeks after their collection from BAXTER by its waste contractor, the ledger amount is adjusted to include also any amount accrued for any shipments which have been collected during the year but not yet finally disposed of by the year-end.

Waste Disposal - Non-Hazardous (£65,283)

This is the total costs incurred with external contractors for non-hazardous wastes sent off-site during 1996, including the local government authority in respect of wastewater effluents, taken from the ledgers.

5.2 Benefits

Ozone-depleting substances cost reductions (£14,310)

BAXTER has reduced usage of these substances considerably. The benefit stated has an element of both saving and cost avoidance. The figure represents the reduction in the quantities consumed per unit of product produced in 1996 as compared to 1995, multiplied by the 1996 cost per unit, and multiplied by the number of units produced in 1996.

Hazardous waste - disposal cost reductions (£1,565)

These savings are due to the reduced use of hazardous chemicals in the laboratory, and to the reuse of chemicals from Baxter by the local college.

Hazardous waste - materials cost reductions (£4,455)

These are the purchasing costs saved due to the reduced use of hazardous chemicals.

Non-hazardous waste - disposal costs reductions (£1,685)

This is the savings in costs of landfill.

Non-hazardous waste - materials cost reductions (£180,716)

This relates to the reductions in the quantities and costs of packaging materials such as pallets. These are used in transporting both materials incoming into BAXTER from its suppliers, and products delivered from BAXTER. The amount reflects the combined effect of a number of different initiatives. Over half of the benefits arise from an arrangement with an internal customer in the UK, who returns the pallets on which BAXTER products

are delivered. Another benefit was achieved by developing a re-usable container for the raw materials that an internal supplier delivered to BAXTER. In order to quantify more easily this amount, a special accounting code was introduced in the ledgers. Finally, some benefit results from arrangements made to repair rather than replace damaged pallets.

Recycling Income (£ 6,933)

Pallets that are beyond repair for Baxter are sold to another company. The recycling income results mainly from the money paid by this company for the old pallets.

Energy Conservation - cost savings (-£ 111,335)

This amount represents the total benefits (negative, here) arising from energy efficiency measures affecting both oil and gas combined. The reason for this being negative in 1996 is that a lot of facility expansion came on stream in that year but was effectively underutilised for most of the year. However, it still had to be fully serviced with air conditioning, heating and lighting, so that there was a high fixed overhead element which was temporarily not matched by a corresponding increase in the volume of output. This anomaly will resolve itself in 1997 when output volumes will rise so that all facilities are fully utilised.

Packaging cost reductions (£83,036)

Because of the nature of Baxter's products, and the need to protect them, in distribution, packaging is both a major environmental issue and a major cost. Strenuous efforts have been, and continue to be, made to reduce its quantity and cost.

Computing this amount was troublesome because of the quantity of data required. Packaging data had to be collected for each of cardboard, plastic and paper, and over three separate production processes. For the calculation of 'Cost avoidance in report year from efforts initiated in prior years back to 1993', all this data had to be collected over three years. Continuing reasonableness checks on the data were made in order to identify and eliminate any errors.

As well as the direct benefit to Baxter which this amount measures, there is a further indirect benefit since reductions in packaging quantities also mean savings in waste disposal costs for Baxter's customers, thereby enhancing Baxter's competitive position.

Employers' Liability Insurance (£7,845)

This item reflects the reductions in insurance premiums paid because of effective management of the risks involved. The total benefit is in fact twice this amount, but the other half was considered to be attributable to health and safety measures.

6 Conclusions

The conclusions of those involved in preparing the BAXTER EFS were that there had been few problems in principle once the methods used in the corporate EFS were under-

stood, and that the main work required by the exercise had been the collection and processing of the data, though this could be substantially reduced in future years. The preparation of future EFS's will take far less time, because much had to be developed and learned only on the first occasion that this was done. Furthermore the calculation of the 'Cost avoidance in report year from efforts initiated in prior years' required a major effort only in this first year.

The success of the exercise depended crucially on the quality of BAXTER's records, not only in accounting but also operational records from production and logistics. Without full and accurate capture of data at source over a period of time, preparation of the EFS would have been at best difficult, even impossible. Problems still arose since this data was not always held in a form in which it could be immediately used in preparing the EFS, so that further work was needed in extraction, and a close dialogue and interaction was needed between the EFS team and the various data-holders. The environmental team plans in future also to systematise data collection through the year by requesting it to be provided monthly to be stored on their database, so that this does not again have to be compressed into a limited period at the year-end.

The concept of cost avoidance in particular needed ample explanation and practice before it was clear and could be modelled in a spreadsheet programme. The case study by Bennett and James (Tuppen, 1996) on the EFS at corporate level served as a manual to guide the BAXTER staff who were responsible. The format and bases of the corporate EFS were followed both because it provided a valuable guide, and for maximum comparability. Comparability was also considered important for possible further facilities producing their own EFS's.

An unexpected but valuable by-product of the exercise was the value gained simply from carrying out the process, which provided an opportunity for the environmental staff to become more familiar with the activities of their colleagues in other areas. The need to involve staff from other departments in providing information also raised the profile of the environmental programme, and reinforced the perception that environmentally positive actions can also be profit-enhancing.

It is too early yet to report on the use of the BAXTER EFS in practice. However the exercise has established that the preparation of a facility-level statement is not only possible but achievable, dependent - crucially - on the existence of full, reliable and accessible records, both financial and non-financial; and that independently of the potential use which might be made of the output, the process itself is of value for those involved.

Reference

C. Tuppen (ed.), 1996, Environmental Accounting in Industry: A Practical Review, London: BT.

Appendix: The BAXTER environmental financial statement

Environmental Costs

	£
Costs of Proactive Programme	
Environmental personnel costs	52,036
Environmental education	4,025
Environmental fees	9,000
Pollution controls: operations and maintenance	24,900
Pollution controls: depreciation	6,205
Environmental management system (IS310)	10,000
Environmental monitoring	13,150
Outreach activities	12,815
Total Costs of Proactive Programme	**132,131**
Remediation and Waste Disposal Costs	
Waste disposal - hazardous	12,517
- non-hazardous	65,283
Total remediation and waste disposal costs	**77,800**
Total Environmental Costs	**209,931**

Environmental Income, Savings and Cost Avoidance

(associated with environmental initiatives in the report year)	
Ozone-depleting substances cost reductions	14,310
Hazardous waste - disposal cost reductions	1,565
Hazardous waste - material cost reductions	4,455
Non-hazardous waste - disposal cost reductions	1,685
Non-hazardous waste - material cost reductions	180,716
Recycling income	6,933
Energy conservation - cost savings	(111,335)
Packaging cost reductions	83,036
Employers' liability insurance	7,845
Total Income, Savings and Cost Avoidance for Report Year's Initiatives	**189,210**
- As a percentage of the costs of proactive programme	*143%*

Total income, savings and cost avoidance from report year's initiatives	**189,210**
Cost avoidance in report year from efforts initiated in prior years back to 1993	**834,524**
Total income, savings and cost avoidance	**£1,023,734**

Detail on income, saving and cost avoidance from 1996 activities

Savings & Income	Cost Avoidance	Total Financial	Benefit
Ozone-depleting substances cost reductions	10,143	4,167	14,310
Hazardous waste - disposal cost reductions	1,565	-	1,565
Hazardous waste - material cost reductions	4,455	-	4,455
Non-hazardous waste - disposal cost reductions	220	1,465	1,685
Non-hazardous waste - material cost reductions	180,716		180,716
Recycling income	6,933	-	6,933
Energy conservation - cost savings	(261,662)	150,327	(111,355)
Packaging cost reductions	(1,899,006)	1,982,042	83,036
Employers' liability insurance	7,845	-	7,845
Total Savings	**(1,948,791)**	**2,138,001**	**189,210**

(- implies not applicable).

Examples of undetermined costs

- Cost of substitutes for ozone-depleting substances and other hazardous materials (this is a relatively minor cost)
- Capital costs of modifying processes other than adding pollution controls (this is typically offset by non-environmental benefits)
- Environmentally-driven materials research and other research and development (this is typically offset by non-environmental benefits)

Examples of undetermined savings

- Immediate savings realised by our customers
- Provide potential to become more competitive, benefit in future sales review
- Record-keeping and administrative costs
- Reduction in liability exposure resulting from tank removals, waste-site evaluations and other risk-management programmes
- Increased goodwill and employee morale

4.4.2 Life cycle costing and packaging at Xerox UK

Martin Bennett
Peter James

1 Description of the company and its environmental effects

Xerox Ltd is a subsidiary of Xerox Corporation, selling its products to markets in Europe, the Middle East and Asia - some 80 countries in all. It employs 21,000 people and has total sales revenue of approximately £3 billion. It began as a 50:50 joint venture between Xerox and the British company Rank plc, and was previously known as Xerox, but is now a wholly-owned subsidiary of Xerox Corporation.

Its core business is manufacturing photocopiers, most of which are leased rather than sold to customers. However, it now defines itself as 'the document company' and provides a wide range of products and services which allow business customers to capture, create, store, print and distribute documents. Xerox defines its primary mission as 'to develop, manufacture, market and service a range of document processing products. The principal goals of the company are: customer satisfaction; employee satisfaction and motivation; market share; return on assets.'

Xerox has a reputation for constant quality improvement. Two of the instruments it uses to support this are benchmarking to guide the setting of goals, and their 'quality improvement teams' (QIT's). A QIT is a multi-disciplinary team of people brought together from several different functions across the company in order to address a problem, which is often based on a prior benchmarking process. Both benchmarking and QITs played a role in the project set up to reduce the use of packaging material, which is the subject of this case study.

Xerox has manufacturing plants in the UK (Mitcheldean) and the Netherlands (Venray), which then ship most of their output to the European Logistics Centre (ELC), also in Venray. The ELC then ships to the 18 operating companies throughout Europe. Some of these operating companies are part of Xerox, others are run by contractors who also handle other companies' goods but employ specifically-trained delivery personnel to install the Xerox products.

This case study is on a project to reduce the quantity of packaging wastes involved in the logistics chain from the factories to the ELC, and onward to operating companies and customers.

2 Environmental management

Xerox has an enviable reputation as one of the leaders in Western industry in quality management and continuous improvement. It was the first winner of the European Quality

Award in 1992, and applies the total quality management (TQM) concept throughout its business, including in its environmental management. Each of its main business units carries out an annual self assessment and validation, based on the European Quality Award template. Impact on society, including environment and community affairs, forms part of this.

The fact that Xerox leases out its products has led to a number of environmental improvements. Because the worn-out or out-dated products remain in their possession, the company is encouraged to look for ways of re-using either whole machines or their components and materials. This has led to a successful re-processing centre at Venray, the Asset Recovery Operations.

In 1990 the company established its Environmental Leadership programme, whose goal was summarised as 'waste-free products from waste-free factories'. The following initiatives resulted from this programme:

- Introduction of environmental management systems at all sites, with the aim of achieving certification to BS7750/ISO14000.
- Elimination of hazardous materials from manufacturing.
- A design-for-environment initiative aimed at minimising environmental impact over the whole life cycle of the product, and maximising durability and reusability, for example by making the products easy to disassemble, interchangeable and compatible across a wide range of products.
- a number of waste-minimising initiatives, which reduced landfill by more than 75% between 1993 and 1997.

The experience of re-using copiers has taught Xerox the importance of considering the full costs and benefits of environment-related activities. The environmental and packaging staff decided to apply this to packaging, which is an important cost in their business.

3 Management accounting

Although Xerox's logistics costs are incurred by operating companies and reflected in their profits, its Logistics function is managed from the centre. The reason is to combine two potentially conflicting aims. Firstly, Xerox's philosophy is to devolve responsibility to operating companies, which is reflected in evaluation of their performance against profit and revenue targets. On the other hand, in logistics, economies of scale are obtained by being holistic in looking at the whole of the supply chain.

The ability to identify these potential economies of scale is one of the ways in which the corporate centre is able to add value to the business operations. One simple example might be a shipment from the Netherlands to France, that en route can deliver a shipment to another destination in Belgium, thus avoiding duplication.

The solution found to this trade-off is that all logistic costs are incurred and captured at operating companies, but the costs are also pulled through to the centre who can then

look for possible opportunities for cost savings and operational improvements. This method of accounting for logistics costs facilitated the work of the Quality Improvement Team on packaging.

Up to a decade ago, the logistics costs were not measured at company level, but were embedded in product costs. Estimates of their total amount ranged widely, from US$100 million to $600 million per year, and without systematic measurement it was not possible to be more exact. When it was decided to measure the logistics costs at company level, for the first 3 years this could be done only by means of questionnaires and direct inquiry. However, this has now been incorporated into the general ledger coding systems and it is part of Xerox's regular management information.

4 Problem definition

In order to do more than simply harvest the initial 'low-hanging fruits' of environmental improvements, more thorough analyses of business processes and costs, such as life-cycle costing, are needed in order to identify long-term strategic opportunities. Discovering this kind of opportunity was the aim of the QIT which examined packaging in the logistic chain.

5 Response: life-cycle costing of packaging

When the costs of logistics had been made visible in the new accounting system, logistics was targeted as an area where significant cost reductions should be possible by taking a holistic view. Based on the figures generated by the new system, the costs of logistics were estimated to be approximately 12-13% of revenues in 1989. The long-term target was to reduce these to 6%.

A QIT was set up with the target of saving £16 million on the total delivery process, including £1 million from packaging. It was soon apparent that this could not be achieved solely by focusing on packaging, but that a broader, multi-functional review was needed, looking at all parts of the logistic cycle, including end-delivery crews, manufacturing, and the operating companies. It then became clear that both cost savings and environmental improvements were possible.

This cost analysis, using quality costing principles, required the collection of a broad range of data from several different sources. These, included outside contractors, where they handled the final stage in the chain of making deliveries to customers (which was found to account for 50% of total distribution costs). This analysis produced some unexpected results. For example, a careful examination of polystyrene packaging revealed that, although its purchase costs were low, the total costs of using it were high because manufacturers would deliver only in large quantities, which made expensive storage facilities necessary.

5.1 The totes solution

Previously, 23 different pallet and pack sizes were used to package the products. Sometimes the wrapping or the pallet could be re-used for transporting an old machine back to Xerox, but usually the packaging would go to waste because it did not fit the old machine, or because the customer had no old machine to return. This meant losses in several ways: the purchasing costs of the material, the cost of its disposal, and costs of packaging the old machine in something else.

To avoid this a standard 'tote' was devised. This is a pallet, with collapsible sides and a lid, which can contain a range of Xerox products. The tote has collapsible sides so that it can be made small when empty in order to save space in transport.

The requirements which the tote had to meet were:

1. It should replace all other packaging;
2. If possible, a single type of totes, robust and long-lasting, should suit the whole product range;
3. It should be suitable for both new machine delivery, and also to return carcass hulks to the Asset Recovery Operation;
4. The design should incorporate quick-release mechanisms in order to minimise de-palletisation time;
5. The totes should be stack-able and collapsible, in order to save space.

One challenge was to design a tote which fitted not only all 23 current product-lines but also around 40 old product-lines. Although these were no longer being manufactured, since Xerox products have a long working life (typically around 15 years), they were still being returned by customers at the end of their lives. An analysis was also done of all the new product-lines likely to be introduced in the next 7 years, in order to 'future-proof' the design.

It was quickly realised that a single tote design would not be adequate to cope economically with the whole product range, which range from small desktop copiers to large floor-standing machines. A trade-off had to be made between on one hand standardising the totes, and on the other hand customising totes in order to fit with product sizes. However with careful design two basic designs of totes were found to be sufficient, a small and a large version. The first was a modification of an existing plywood design from a Swedish supplier. The large tote is made of steel, with optional extensions being available for greater flexibility in handling larger copiers. One result of using totes is that, thanks to clever design such as quick-release straps, de-palletising times have been reduced from 12 minutes per product to only 30 seconds.

5.2 Cost analysis

The logistics chain includes manufacturing, the ELC, operating companies, customers and finally the asset recovery operations. The costs which are incurred in all these stages

were gathered and compared for both traditional packaging, and the new totes system. The costs of course differ for different product types and delivery destinations. Therefore, analyses were made for each possible combination of 18 destinations and 23 product-lines. In one typical example (see Appendix), the overall costs of traditional packaging over the whole of the logistics chain amounted to $59.79, compared with only $47.71 for the tote system.

The new tote system saves money in total, but may mean extra costs at some stages of the chain which are more than compensated elsewhere. This is important for two reasons.

Firstly, this illustrates why a central, holistic view is needed to in order to discover the advantages of the new system. Secondly, because it has implications for the evaluation of the performance of the various stages of the chain. A budget-holder at one stage in the chain may experience increasing costs due to the new system, and this should be taken into account when evaluating their performance. This requires that the budgets and performance targets of internal sub-units are adjusted to take into account the gains expected due to using totes, as well as any other changes. When a budget-holder is an external contractor, the conditions of the contract might need to be re-negotiated. These negotiations are done at a corporate level rather than by each separate operating company (although the costs which are incurred are eventually charged back to the operating companies) because this provides an opportunity to identify further efficiencies. An example of such an efficiency gain is the drop-off in Belgium en route from the Netherlands to France, which was described earlier.

5.3 Phases of the project

The original QIT was set up and produced its initial proposals in 1993. Trials started in 1994 and full implementation of the totes across Europe was achieved in early 1997. The system was implemented in three phases.

In phase 1, totes were used for only the distribution part of the logistic chain, i.e. from the ELC onwards. For the prior stage, from manufacturing to the ELC, the old system with pallets was continued. Phase 1 lasted for 3 months and covered only France and Germany, using 200 totes of the small and 200 of the large type. During this trial phase, close contact was kept with those operating the system, and their feedback was collected through questionnaires and meetings, as well as through direct observation. This resulted in some redesign of the totes, and helped to identify which operational processes had to be changed.

Phase 2 extended the use of totes to all operating companies in Europe, using 3000 totes of each type for an extended trial.

Finally in phase 3, totes were used also for transport to and from the factories in Mitcheldean and Venray. In Venray a Tote Pool was installed, where spare totes were stored and damaged ones repaired. A Tote Planner was appointed to monitor and control

the movements of the totes. At present 28,000 small, and 20,000 large totes are in use, representing a total investment of between $4 and 5 million at an average cost of approximately $100 per tote. This compares with an average cost of only $20 for the packs previously used, but this extra capital cost is compensated for by the savings in use and re-use.

Within this part of the logistics chain, the totes project has created a totally closed-loop system - the first in Xerox. This has required changes in procedures in several different areas of the company, including setting up a financial procedure to charge operating companies for each tote which they receive, which is then re-credited to them on its return - i.e. a deposit system. Although simple in concept, this required a change to the company's invoicing systems which was a major and time-consuming change in practice.

As part of the centralised tote planning and control process, all totes now have an individual identifying bar code. This means that they can be individually tracked throughout the process. It is a complex task to ensure that sufficient totes are available to cope with fluctuations in manufacturing volumes, whilst at the same time minimising the company's total investment in totes stock. To manage this problem, the Tote Planner is directly linked into the company's manufacturing planning systems.

5.4 Results

The main benefits of the system are quantified in the whole-chain cost analyses (see Appendix). In total, the investment of $4million to $5million in totes is estimated to have generated directly quantifiable annual savings of $1.2M. There are also further, intangible benefits such as easier handling, reduced administration workload since fewer different types of packaging now have to be purchased, and benefits in customer service since the quantity of packaging with which customers are left is reduced.

6 Conclusions

The project demonstrated the value of a holistic cost analysis over the whole of the logistics chain to identify potential environmental and cost saving opportunities. These are costs which are being incurred, but which under in normal methods of reporting are not usually made visible to management.

The outputs from the existing accounting systems are not always directly helpful in projects like this, which by definition aim to look at the business in new ways which have not yet been reflected in the regular reporting process. Therefore the analyses done for this project depended heavily on other sources of data, such as operational. However, the traditional accounting system rests on several sub-systems of data, usually generated in the first place primarily for operational reasons, which are then available to use in one-off project analyses such as this. Companies which have developed more sophisticated internal financial reporting systems (such as Xerox's corporate logistics system) are more

likely also to have developed support systems whose data can then be used for such further purposes.

Some improvements, such as this, can be discovered and implemented only through analysis done at the centre. However, in implementing them attention has to be paid to the principle of local autonomy. Centrally-driven changes have to be introduced with care and tact in order to avoid the appearance of corporate intrusion which might dis-empower and de-motivate local managements. It is also necessary to ensure that the expected benefits arising from the changes are in fact reflected in the operating companies' budgets and targets, which are agreed annually between each operating company and the centre.

Finally, the totes project showed the importance to the process of a supportive corporate culture, since the system was devised and developed by a cross-functional Quality Improvement Team. These teams are an established part of Xerox's culture, and the project benefited from being able to build on this.

Appendix to section 4.4.2

France - 5317 + ADF (implement in ELC & Manufacturing Only)

Activity	Current Pack ('95$/Unit)	Proposed Tote ($/Unit)	Proposal B/(W)	Saving/(On-cost) Accounted for in:
Packaging Material Cost	14.02	6.54	7.48	ELC/Manuf
Pack Time-Mitcheldean	1.70	0.80	0.90	M'Dean Manuf
Transit Mitcheldean to ELC	3.41	5.76	(2.35)	ELC Inbound Freight
Transit ELC to Platform (Stains)	3.04	5.13	(2.09)	OpCo Inbound Freight
Unpack time Platform	1.70	0.80	0.90	Contactor Tariff
Platform Pack Disposal	5.20	--	5.20	Contactor Tariff
Platform Purchase New Packs for Carcase Returns (pallet and case)	10.27	--	10.27	Contactor Tariff
Platform Carcase Pack time	3.33	0.80	2.53	Contactor Tariff
Transit Platform to ARO (Oostrum)	3.85	6.50	(2.65)	ELC Inbound Freight
Transit ARO to Mitcheldean	6.67	6.67	--	Inter-Plant Freight
Platform Storage Space Saving	4.00	--	4.00	Contactor Tariff
Pack Disposal at ARO/MO	2.60	--	2.60	ARO Recharge (Supply Trading)
Consolidation/Handling Costs	--	0.43	(0.43)	Manufacturing?
Tote Losses/Repair (15%)	--	1.83	(1.83)	Tote 'Budget'
Line Balance Contingency (10%)	--	1.22	(1.22)	Tote 'Budget'
ARO De tote & Repack Activity	--	6.23	(6.23)	ARO Lab (R/c to S Trading?)
ARO Purchase New Packs	--	5.00	(5.00)	ARO (Part of ARO Recharge
Total	59.79	47.71	12.08	

4.4.3 Cost of waste at Zeneca

Martin Bennett
Peter James

1 Description of the company and its environmental effects

Zeneca is a British chemical company with a turnover of 5 billion pounds. Almost 40% of Zeneca's 30,000 employees work in the UK. The company consists of three major divisions: pharmaceuticals, agrochemicals and specialties.

At the corporate level, the department which is responsible for developing and improving process technologies, and for managing the production sites that produce for all three Businesses, is the Zeneca Manufacturing Partnership (ZMP). Within ZMP, the department responsible for improving process technologies is the Process Technology Department. Furthermore, at a corporate level there is a department for Safety, Health and Environment (SHE).

Zeneca's business involves the production of high-value chemicals such as agrochemicals and drugs. These usually involve complex multi-stage syntheses which can generate large amounts of waste in aggregate, some of which may be hazardous. Waste reduction is therefore a major environmental objective. The company is also concerned to minimise any risk of environmental incidents during production, and to minimise any environmental, safety and health impacts which could arise when customers use its products.

This case study focuses on one site of the company, the Huddersfield Works, and on a project which was initiated by the environmental manager of the Agrochemicals Business and carried out at Huddersfield on the costs of waste. The Huddersfield Works covers 100 hectares and about 1400 people work there, including the Process Technology Department. Because of the large number of different products, the rapid developments in technology, the large variations in production quantities, and the often complex production processes, the site structure is complex.

The Huddersfield Works is managed by ZMP, and includes a landfill site for solid waste and effluent treatment plants. Some waste is sent to off-site landfills and incineration plants. The treated effluent is sent to the local water company for further (biological) treatment. There is a combined heat and power plant that produces cheap steam and electricity for the site.

2 Environmental management systems

To support the implementation of its environmental policy, Zeneca has a list of 19 Group Safety, Health and Environment Standards, with associated guidelines. The main components of environmental management are an environmental management system at each

site, regular assessment of environmental impacts and regular auditing. At the end of each year the Chief Executive Officer of every business reviews SHE performance. Following his review he delivers a Letter of Assurance to the Zeneca Executive Board, outlining the extent of compliance with company standards and indicating areas, plans and time scales for improvement.

3 Management accounting systems

The company aims to allocate costs to businesses as specifically as possible, so that each business is aware of its own costs. The principle behind this is that an awareness of costs at business level will help to identify and achieve possible cost reductions. Since this includes environmental costs, the polluter-pays principle is effectively being applied within the company.

Huddersfield Works is divided into shared service cost centres and manufacturing cost centres. Each of these centres has a cost centre manager who has the responsibility of maximising efficiency and minimising cost, whilst respecting SHE and other constraints. The shared service cost centres include human resources, production planning, boiler, landfill site and the on-site effluent treatment plants. These centres' costs are allocated to 24 manufacturing cost centres, based on discrete buildings and productions processes. The 24 manufacturing cost centres then re-charge their costs to the businesses that use their services. This re-charging is done as far as possible on the basis of actual costs, but if this is not possible then a reasonable apportionment basis is used.

The costs of activities that serve several different businesses and products of Zeneca (the shared services) are not always easy to share. For example: how should the costs of additional infrastructure, such as on-site roads and effluent treatment plants, be allocated in the case of a new business being started on the site' The principle adopted is that specific additional requirements should be borne by the business unit which requires them, but if there is a general increase in production volume the costs will be charged back to all users. ZMP is now developing a capital allocation system which is based on forward requirements rather than on past actual use.

The SAP business computer system is used to record and process operational costs. It includes recipes for each product, estimates of the expected costs, and historic records of how much has actually been used. Variances between actual performance and pre-set standards are regularly reviewed, and explanations are sought. Possible explanations for a variance could be the development of more effective processes, variations from the optimal quantities of products being produced in each batch, or simply measurement errors. If variances persist over time, recipes may be adjusted or improvements in processes may be sought.

One important environmental cost is the cost of the landfill site, which has recently risen substantially due to the new UK landfill tax. The operating costs of the landfill are allo-

cated yearly to the plants that use it on the basis of the weights of their wastes, since weight is the basis for the landfill tax. The capital costs of the landfill, mainly the digging of holes, are apportioned back on a basis which includes both weight and volume, since volume is the main determinant of the length of life of the holes.

4 *Problem definition*

Although the nature of Zeneca's products and production processes have traditionally meant high quantities of wastes, until recently high profit margins have meant that there has been only limited financial pressure within the business to reduce these. However this situation is changing as profit margins are now becoming tighter in a number of areas.

When Zeneca was formed it inherited an old ICI target of 50% 'across the board' waste reduction ' interpreted as applying to every site. However, although this was successful in generating a high profile for waste reduction and creating a climate for change, there were several disadvantages of this approach. It had no environmental logic, since all wastes were treated the same, and was not cost-effective because all wastes and sites were given the same target, regardless of whether the waste reduction opportunities in each situation were low-cost or high-cost.

It was decided that what was needed was a better overall picture of the costs of waste and the possibilities to reduce these costs; in other words, an insight into the cost-effectiveness of different alternative waste reduction strategies.

5 *Response: defining the cost of waste*

A new approach was chosen to measure and reduce waste, called the 'Cost of Waste' programme. The aim of this programme was to clarify the costs of waste and to present them alongside other business costs. This, it was hoped, would stimulate the separate businesses to reduce these costs, as it would be clear how much money they could save and how.

The costs of waste were defined as:

1. Materials costs - The purchase cost of all materials entering the process that do not form part of the final product (e.g. excess reactants, lost yield, auxiliary chemicals).
2. Waste treatment costs - Materials (caustic, activated carbon, etc.), labour, energy, landfill, incineration, effluent treatment plant, legal charges, transport.
3. Capital costs - All capital allocation for waste treatment plant and landfill expansion.

The waste costs do not include 'occu-pacity' costs as Zeneca terms them - i.e. the expenses incurred in processing materials which end up as waste rather than as saleable product, since these are very small compared to the above.

First a pilot study was carried out to analyse the costs of waste involved with a single specific product. The data to analyse the materials costs of the pilot product was taken from process mass balances - which was helped by the installation of a new effluent monitoring

database - and the product cost sheets. The treatment costs were taken from the existing charges from the Works, with apportioned calculations where no charge was levied. The capital costs were calculated by apportioning the cost of relevant plant and converting this to a discounted per-annum cost over a nominal 15-year plant life.

This assessment showed that the costs of waste were dominated by the costs of purchasing raw materials which were later wasted in the process, and which later had to be paid for again for their disposal. For the pilot product, wasted material accounted for 36% of total product costs, waste treatment for 15%, and capital costs for 6%. All the wasted materials costs and one-third of the treatment costs were judged to be variable costs, giving a total figure of 41% of total product costs which were variable costs which could therefore theoretically be influenced by actions in the short to medium-term.

The high costs of waste for this particular product are especially striking since it has been in existence for 10 years and has been subject to process development throughout that period to improve chemical efficiency and reduce wastes. Subsequent analyses of further products found that these figures are not atypical, both in size and in their domination by the costs of wasted materials. The explanation which was identified was that the chemists had previously focused on increasing the yields from core materials and expensive materials within processes, and had merely aggregated all the others together. The costs of wastes approach made losses of other materials more visible, and therefore helped to identify improvement opportunities for them.

When the exercise was extended, it was found that over the Huddersfield Works as a whole the waste costs amounted to around £43 million a year - almost half of total manufacturing costs. Although some were not preventable, it was calculated that there were £10 million per annum of potential annual savings. One participant commented: 'when people get this kind of data they get very excited - much more so than with general corporate waste reduction targets.'

Zeneca is now in the process of achieving these savings, resulting in both cost savings and environmental improvements. The results from the programme have made it clear with hard data that waste reduction pays off, and enable priorities to be set, by starting with the most profitable projects. The cost of waste approach now forms a part of Zeneca's six-monthly strategic review process. The costs of wasted materials and waste treatment are calculated for each process and product, and included within the review documentation. The analysis also contains data about development/improvement options with their likely environmental and financial returns, based on four key parameters:

1. replacement of costly raw materials
2. removal of raw materials
3. reducing the quantities of raw materials used
4. the recovery or recycling of raw materials

This process has now been made easier by a software package.

6 Conclusions

Organisational factors are major determinants for the success of environmental accounting. The fact that ZMP's Process Technology Division is located at the Huddersfield site, where much of production takes place, was important in achieving the savings. It is important that there is good communication between process developers and site production staff, which was possible in this case since they worked on the same site.

Most of the work on the Cost of Waste project was done by chemical engineers and manufacturing chemists, with accountants playing only a minor role. The project made little direct use of accounting data or the accounting systems, since the data on production which was available from the accounting system was often not sufficiently precise and detailed to be of use in this type of exercise. Also, the technical expertise of chemists and engineers is needed to know and understand where production processes can be changed in order to save materials and money, and make environmental improvements.

It was thought that there was potential to involve the accounting function more in future exercises (and/or updates of this exercise), by their maintaining a comprehensive and up-to-date database of materials costs data, and doing some of the basic computational work. However the main part of the exercise was outside the competence of most accountants, who would not fully understand crucial aspects of chemical processes such as the distinction between 'spine' chemicals (which end up in the final product) and 'crutches' (which enable reactions and separations). This means that they would not be in a position to suggest improvements, but at most to check the proposals made by chemists and engineers.

Much of the data needed by the project already existed. The task of the project team was mainly to collect what was relevant and to put it into the right perspective by developing an appropriate method of data analysis. Developing this method, and sharing common costs between the many products, was the most difficult part of the project. This suggests that it is best to start by closely examining all the existing information, instead of setting up new systems at the outset.

4.4.4 Evaluation of the environmental performance of products at XYZ plc[1]

Martin Bennett
Peter James

1 Description of the company and its environmental effects

XYZ plc is a major UK electronics company, both manufacturing and providing services such as electronics-based business systems, in particular (in this project) property security systems such as intruder alarms. Because of the wide range of activities in which it is involved, its size alone means that it has significant environmental impacts, not only through its manufacturing operations but also through the operations of its vehicle fleet and buildings (both commercial and industrial).

Amongst other activities, the company manufactures and installs in customers' premises a range of intruder alarm systems, which are permanently on-line to a central control unit through a telecommunications infrastructure. One component in this is a device which interfaces between the physical system on the customer's premises and the national telecommunications system.

2 Environmental management

XYZ is regarded as one of the leading European companies in terms of environmental management and reporting, and has in its environmental policy committed itself to a long-term objective of minimising the impact of its operations on the environment through a programme of continuous improvement. There is a corporate environmental unit, which has responsibility for preparation of the company's environmental report. This report is a major driver of target setting and data collection. There are also further environmental staff in XYZ's various business units and divisions.

XYZ's environmental management activities are structured around the European Quality Award, which provides a template for assessing business performance. In judging for this, marks are given for broad commitment to continual improvement and its achievements in practice, with environment and community accounting for 60 of the 1000 points. Each major unit has to report on its activities relevant to this area, and set targets for further action.

[1] This case study looks at the evaluation of the environmental impacts of two products, one of which was still under development at the time that the case was being prepared. Because of the commercial confidentiality involved, the company has requested anonymity and is therefore referred to here as 'XYZ plc' (not its real name). The two products are referred to respectively as 'Product A' and 'Product B'. Although certain details concerning the company and its activities have been disguised in order to protect its confidentiality, no changes have been made to any of the main content of the original case study concerning the assessment of three alternative methods of evaluating the environmental impact of products.

XYZ is placing increasing emphasis on taking environment into consideration in product design. This has resulted in the development of a design matrix which aims to improve understanding of how decisions at the design stage affect end-of-life options, though this matrix has not yet been operationalised. Also, XYZ has been involved with the Industry Council for Electronic Equipment Recycling (ICER) which has been analyzing end-of-life recycling and collection options, and developing eco-design guidelines. However, a number of XYZ staff believe that their company still lacks a systematic approach to this area and that more needs to be done to link product design and environment.

3 Management accounting

Costs are recorded through the General Ledger. The system requires that every expense is allocated to the right product or product group, in order to avoid cross-subsidization and to assure correct costing. In practice, however, some of the apportionments may inevitably be arbitrary to some extent. XYZ is very decentralised and much of the management accounting is done at a local level, sometimes using differing definitions. Hence, environmental managers have found it difficult to get consistent financial data.

The main method used to evaluate proposed investments in new projects is the incremental pay-back method. This calculates firstly the amounts of the differential (incremental) cashflows as between the proposed new investment, and the existing method (or other appropriate base case); and then how quickly these differential cashflows will pay back the required investment. The usual maximum pay-back acceptable period is in the range of 3 to 5 years.

The costing of internal services is not yet optimal. For example building-related costs, like heating, are still pooled and allocated to the various users of the buildings based on the floor areas which they occupy rather than on the actual heating costs which they incur. This basis provides users with little incentive to cut down their consumption of heating and light.

In its product costing system, which XYZ is continually developing, so far as possible costs are allocated to the products that caused them to be incurred. However, the end-of-life costs (for example for disposal or recycling) are still not collected, and are consequently not allocated on a correct basis.

4 Problem definition

The bulk of lifetime environmental impacts of products are typically determined during the design stage. Attention is therefore being focused on design for environment (DFE), and companies such as AT&T and Philips have identified sophisticated approaches to this. As part of this, XYZ wants to pay more attention to environmental factors during the design and development of its products, and needs practical tools to support this. The following were the objectives of this study:

a. Assess the suitability for XYZ of three specific evaluation techniques:- 'eco-points', 'eco-compass' and 'eco-costing'. This was done by applying each of these methods, in turn, in a pilot study to evaluate the environmental impacts of two specific pieces of electronic equipment: Products A and B.
b. Examine the general relevance of environmental accounting to XYZ's product development processes.
c. Assess the current availability of the data which would be needed for the three methods of evaluation.
d. Make recommendations on how XYZ should proceed with regard to the environmental evaluation of products (though for reasons of commercial confidentiality, several of the details, including these recommendations, cannot be reported in this paper).

5 Solution: applying the Eco-points, Eco-compass and Eco-costing methods

5.1 The pilot study

One of the XYZ's is an intruder alarm, fitted in customers' properties, which detects the presence of any intruder and immediately reports this, through the public national telecommunications infrastructure, to a security company with whom XYZ is in partnership. The security company can then take whatever action is required to deal with the intruder.

One component in this alarm is a device which interfaces between the physical system on the customer's premises and the national telecommunications system. Two versions of this component (Products A and B) were used as the basis of this pilot study. Product A is the component currently in use; Product B is a potential replacement which is currently in design. If successful, XYZ plans to replace all the Product As currently in use with Product Bs.

The physical design of both components is largely similar. One of the main differences between Products A and B (and one with environmental significance) is that Product B has higher functionality. One feature of this is the ability to be upgraded, and for repairs to be carried out where necessary, by an XYZ maintenance engineer remotely on-line over the telecommunications infrastructure, rather than requiring a site visit (and therefore travel) as does the present Product A.

Three possible tools of evaluating the environmental performance of products (in each case, on the basis of a life-cycle analysis) were selected for assessment: eco-points, eco-compass and eco-costing. These methods were selected for evaluation based on their potential relevance to the nature of XYZ's business, and their availability. These were applied, in turn, to evaluate Product B in comparison with Product A, with each tool being assessed against 6 criteria which were identified as desirable in management information generally (see Table 4.4:1):

- precision
- reliability

- comprehensiveness
- understandability (i.e. comprehensibility)
- convenience
- credibility.

These criteria were selected on the basis that the tools had to be not only accurate and reliable, but also useful in practice both for those applying them, and for those receiving, interpreting and acting upon the results.

Based on this, their suitability was assessed for four main purposes which product environmental evaluation techniques can be required to serve:-

1. identifying areas for attention in the product design and development process
2. making choices between different products or different designs of the same product
3. ensuring that products meet specified criteria and/or create no great environmental problems
4. communicating environmental effects to customers and other interested parties.

The purpose of the pilot study was to use the two products as the basis for an assessment of the three evaluation methods, rather than in order to evaluate the products themselves.

5.2 Data availability

Obtaining the data that are needed for the three evaluation methods turned out to be a major problem. The development of Product B is a complex one, with many participants involved. Data on material costs and end-of-life costs such as the ease of disassembly, and the potential value of recovered components and material, were not easily available.

5.3 Product Evaluation using the Eco-points method

A number of eco-points schemes have been developed, of which the best known are those used by Philips and Volvo. They are similar in that they cover all life cycle stages - production, distribution, use and end-of-life. For each stage, the user selects the appropriate materials, processes, usage, and transportation details from the options which are provided in the software. The package then calculates an 'eco-score' for each of these elements, based on a number of points for a given quantity or usage.

With the eco-points method, points are assigned to a number of key environmental features of the product being tested (like material composition and method of disposal), and summed to a final score. The eco-points scheme used for this project was that of Eco-Scan, a computer programme which is based on work done by the Dutch electronics company Philips. Eco-points scores within Eco-Scan are based on a 'distance to target' methodology. The underlying premise is that there is a correlation between the seriousness of an effect and the distance between the current level, and the target level required to achieve sustainability.

As with all such schemes, its value depends on the credibility of the weighting factors used in the calculation. For example, one of the major issues in the design of Product B was the choice of the main raw material. This could be either PVC (which has been XYZ's usual choice in the past) or an alternative, ABS. PVC has been widely criticised in some quarters for potential adverse environmental impacts in its manufacture and disposal, though this is controversial and is disputed by its supporters. The Eco-Scan software is based on the assumptions (which many would challenge) that overall, PVC is a better environmental option than is ABS, and that in both cases landfill is a preferable end-of-life option to recycling. This demonstrates that the conclusions generated by software like this need careful examination, since they depend heavily on the assumptions that are made.

5.4 Product Evaluation using the Eco-compass method

The eco-compass (see Figure 4.4.1) has been developed by Dow Chemical to provide a simple visual summary of the results of life-cycle analyses. It is based on the indicators of eco-efficiency developed by the World Business Council for Sustainable Development, with some minor amendments. The eco-compass has six 'poles', or dimensions:

- energy intensity
- mass intensity
- environmental and health risk potential
- sustainability of resource usage
- extent of revalorization (reuse, re-manufacturing and recycling)
- service extension (this measures the ability to deliver greater service from given inputs, for example by improving durability).

All of these are measured across the product's entire life cycle.

The scoring scale used for each dimension is 0-5, with 2 being the score allocated to the 'base case', i.e. the comparator, or reference point - usually an existing product. The performance of another product or product variant is then scored relative to this, on the following scale:

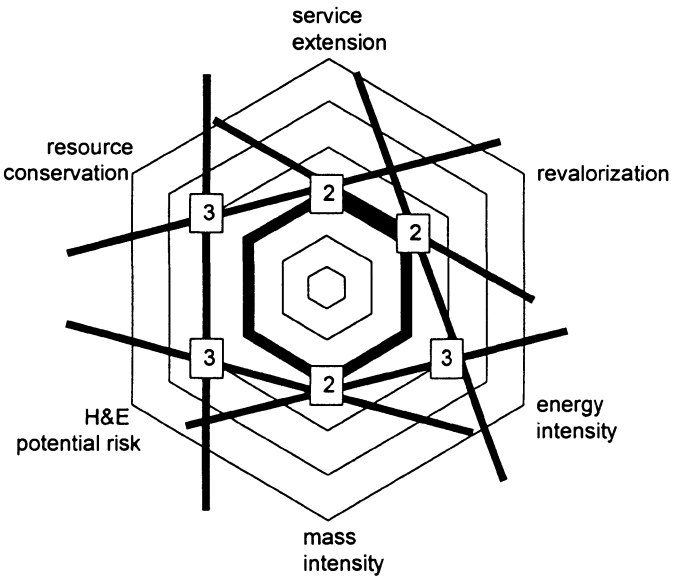
0	1	2	3	4	5
only half as good, or worse	worse, but at least half as good	the same	up to twice as good	twice to four times as good	four times as good

Figure 4.4.1 shows the evaluation of Product B relative to Product A. As with the Eco-Scan (eco-points) analysis, the limited availability of data meant that a full analysis was not possible, which tended to make the differences between the two products appear less than is likely to be the case. Aspects of the result which could change if more data were available include:

- A better score on the service intensity pole for Product B, because it provides more and environmentally better services to customers.

- A better score for the ABS alternative on the health risk pole, if precautionary instead of the present generally accepted assumptions were made about health effects of PVC.
- A much better score for the ABS alternative on the revalorisation axis, because ABS is a plastic which is easier to recycle than is PVC.

Figure 4.4.1 Eco-Compass, evaluating Product B relative to Product A



5.5 Product Evaluation using the Eco-costing method

Eco-costing implies the monetisation of all significant environmental impacts, and the calculation from this of the total environmental cost which is related to a product. The environmentally best product will then be the one with the lowest cost. A narrow definition of environmental costs uses only the internal costs for the company, while a wider definition includes also the societal (or external) costs which are borne by society and the natural environment. The latter are important both for their social responsibility implications and also since there is a trend for such external costs in the long-term to be internalised through taxation and other means. A calculation of the external costs associated with a product therefore offers a way to measure that part of its environmental performance which is not already reflected in the costs being currently incurred by the business.

A review of XYZ's internal product costing methods was not a part of this project, and in any case the data which would have been required were not fully available. However it did become apparent during the project, through contact with manufacturers and disassemblers, that there could be opportunities by making changes at the design and intro-

duction phase to achieve direct environment-related savings for Product B over the life of the project. This is consistent with experience with other companies, where typically whole-life costs are not always calculated in full.

The calculation of external costs requires two elements of data, in sufficient detail and to an acceptable level of reliability:

- life-cycle assessment data on the physical attributes of the product, process, etc.
- a figure for the external costs incurred for each impact, per unit of impact.

The availability of physical data is equally required by an eco-points analysis (though less so for the eco-compass), and this has already been covered in that section.

The calculation of external costs per unit of impact is a major exercise, and this study did not attempt to carry out any such exercises but to access the results of past externality costing studies which are already in the public domain. Despite the status of their authors and the rigour and depth of the studies, their results are often contentious and of dubious reliability. This is confirmed by the wide ranges of values produced for the same environmental impact by different studies, due to the different assumptions and methodologies adopted by different studies. Even the keenest supporters of this approach claim no more than approximate accuracy, though they argue that this is still more accurate than an analysis which does not take this step and which thereby effectively assigns a value of zero.

There are a number of areas where the external costs of Product B could be of economic and social significance, and where internalisation might therefore occur in the medium to long-term: for example, acceptance of some of the more pessimistic assessments of the environmental impacts of PVC, leading to a ban or classification as a hazardous material; more stringent regulations on the disposal of telecommunications equipment; and increased transport costs due to fuel levies, carbon and other environmental taxes and other measures to reduce the environmental impacts of road transport (which could work to the advantage of Product B).

Because of the insufficiency of data, it was not possible to calculate a full external cost for Product B as compared with Product A. The study therefore focused on the area where data is most readily available and where in this case there is also the clearest distinction between the two products - transport. This showed that over the expected volumes of products, there would be a modest but significant reduction in the total external costs of Product B as compared with the comparable total for Product A. A more extensive calculation would require further data on both physical attributes, and the external costs of a wider range of environmental impacts.

6 Conclusions

6.1 Evaluation of the three methods

The three alternative methods were assessed against both 6 general criteria (see Table 4.4.1), and in terms of their suitability for the 4 main purposes which they can serve:

1. identifying areas for attention in the product design and development process,
2. making choices between different products or different designs of the same product,
3. ensuring that products meet specified criteria and/or create no great environmental problems,
4. communicating environmental effects to customers and other interested parties.

The main conclusion is that all three methods have their own distinctive strengths and weaknesses. Therefore, the selection of the most appropriate method depends on the individual situation, and on the specific purpose for which it is to be used.

The strength of eco-points schemes like Eco-Scan is that they provide quick analyses of the overall environmental effects of products, and of how different elements of the design contribute to this. Their main disadvantage is that they depend on subjective weightings of different environmental effects and that these are not always clear to users. Thus, the eco-points method is particularly well suited to purposes 1 (identifying areas for attention) and 2 (making choices). But eco-points are less appropriate for purpose 4 (communication) because an eco-point score is meaningless in itself, and some users may challenge the assumptions on which it rests.

The eco-compass provides a holistic, visual overview of products using six dimensions. It is helpful to purpose 2 (making choices) and, with some explanation, to purpose 4 (communication). Also, when used in a workshop it can contribute to purpose 1 (identifying areas for attention). A problem with the eco-compass is that it requires a reasonably complete life cycle analysis data and also that scoring some of the dimensions may be difficult.

Internal costing is very suitable for purposes 1 (identifying areas for attention) and 2 (making choices). By identifying the areas of potentially high costs, lower-cost alternatives may be found. External costing indicates the areas that are costly to society, and expresses these costs in money (which is a well-known measure), and therefore is especially well suited for purpose 4 (communication). The problem with this method is that there is no consensus on how high the societal costs of certain environmental damages are, and also that data is not equally available in the public domain for the external costs of all types of environmental impact. The figures generated therefore need to be used with care.

6.2 *Implications for Ecomac*

This study suggests that each method has its own balance of strengths and weaknesses and therefore that the relative attractiveness of each depends on the relative importance, in any situation, of each of the criteria. None of the methods can be relied upon always to provide clear and unchallengeable results - all need to be interpreted, and they probably work best in combination. Above all, they all need to be embedded in a product development process so that each method can be used as and when it is most effective.

All methods require adequate data (though this is less critical for the eco-compass than for the other methods), which may not be available unless information systems have been set up in advance to capture it.

The exercise also showed the importance of the methods used to allocate costs. For example, in both the eco-point method and the eco-costing method, a major factor was the allocation to the product of the energy used by the national telecommunication system. Different allocation principles could have produced significantly different results.

Finally, the project demonstrated the importance of good linkages between the different functions involved in new product development. As part of this study, a workshop was organised which brought together these participants, including those from outside XYZ such as representatives of recycling businesses. This provided valuable insights into possible cost-saving opportunities, although only at a late stage in the product development process. If the workshop had been organised earlier, and had the people involved been guided by procedures to collect environmental costs and related data, more could have been achieved. Environmental management accounting is as much about process as about content.

Table 4.4.1 Strengths and Weaknesses of Three Product Evaluation Methodologies

	Eco-points	Eco-compass	Eco-costing
Characteristics	Assigns scores to individual impacts and aggregates these into an 'eco-score' - a cardinal measure.	Scores products on a 0-5 (cardinal) scale on six key environmental parameters - a relative (ordinal) measure.	Calculates internal and/or external financial costs and benefits of a product's environmental impacts, giving a cardinal measure.
Comprehensiveness	Excellent as different databases can be used (including self-generated ones).	The six poles cover most, but not all, issues. Also deals with customer as well as environmental benefits.	Can be comprehensive in principle for internal costs but in practice key data are often not available. Comprehensive for external costs of transportation but not other areas.
Precision	High	Low (wide ranges for each point)	High
Reliability	Reasonable - no more, since it requires considerable judgement and aggregation of different aspects within (though not across) the different dimensions.	Modest - not transparent and depends on assumptions and weightings.	Modest - as for eco-points, depends on assumptions and weightings, and involves loss of transparency. Also requires additional - and equally controversial - process of monetising.
Comprehensibility	Basic principles are clear and well explained in software. However, weighting methodologies can sometimes be obscure.	Aided by conceptual simplicity and clear visual display. However, details of scoring system can be obscure.	High in general since makes use of widely understood concept of costs and benefit. However, methodologies for calculating environment-related costs and benefits can be obscure.
Convenience	Excellent - a user-friendly software package which most people can understand and use within hours.	Easy to calculate if data is present - but needs more data than eco-points.	Requires both environmental and financial data and therefore more time and resources for data collection.

Table 4.4.1 Strengths and Weaknesses of Three Product Evaluation Methodologies (continued)

	Eco-points	Eco-compass	Eco-costing
Credibility	Rests on faith in experts' weighting of different environmental impacts - may be high internally but unlikely to persuade sceptics. One possible response is to use most-likely, best-case and worst-case weightings.	Increased by limited conversion of basic data and a 'stretch' scoring system which is biased towards radical improvement and will therefore please environmentalists. However, reasons for the six compass poles are not completely self-evident.	High internally in that it expresses findings in monetary terms - but assumptions, for internal and especially external costs, can be challenged by sceptics.
Conclusions	Good for internal use - quick comparisons and highlighting key areas of impact. As results are easily challenged, less suitable for making choices or communicating to stakeholders	Good for making comparisons and highlighting improvement opportunities, both internally and externally. However, too aggregated for detailed analysis.	Internal costings are managerially persuasive but can be time-consuming to generate and may not impact budgets for many years. External costings are useful internally for broad understanding and communication of social benefits and potentially valuable to policy-makers. However, basis of calculations can easily be challenged and difficult to apply outside transportation.

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Annex Questionnaire

Eco-management accounting as a tool of environmental management (ECOMAC) 1996-1997

A survey among eighty European companies

Questionnaire

This questionnaire belongs to the ECOMAC project, which is an EU funded research project that is carried out in Italy, Germany, The Netherlands and the United Kingdom.

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QUESTIONNAIRE ECOMAC PROJECT

The ECOMAC project is a project supported by the European Commission (DG XII, Environment and Climate). It aims to find out how management accounting can be used as a tool of environmental management. The project leads to the Ecomac Framework that helps businesses to adapt their management accounting systems and practices so as to make them useful instruments in environmental decision making within firms.

The research is scheduled to take place in four European countries: the Netherlands, Germany, Italy and the United Kingdom.

It involves a number of case studies and a survey among firms in different economic sectors. This questionnaire is part of the survey. It is intended that the firms participating in the survey inform the research team about the way they deal with environmental matters and how management accounting (in particular environmental costs and benefits) plays or could play a part in it.

In accordance with the dual interest of the survey (environmental management and management accounting), it is expected that both an environmental specialist and a financial controller are needed to fill out the questionnaire completely. By such a common contribution it is hoped that the questionnaire can be completed without much difficulty. In principle, the survey is based on interviews but certain data may be acquired by other means (such as documents).

See also the Instructions (page 14 and 15). If more space for answers is required, please make use of the sheet at the end of this questionnaire.

Name of firm: _____

Contact person: _____

Telephone number: _____

Name of interviewer: _____

I NATURE OF THE FIRM

01a Indicate your firm's major product line.

_____

_____

b Give relevant NACE code (3 or 4 digits).

_____

_____

02 What level is considered in this questionnaire?

- O Corporate
- O Divisional
- O Plant
- O Other: _____

03 Number of employees (at level considered)

- O 5-50
- O 50-250
- O 250-500
- O >500

04 Most recent annual sales (in ECU):

_____

_____

05 Give the organisation structure of your firm: the place of the firm with a broader organization, its own structure (business units, departments etc.).

06a What is your firm's general mission and strategy?

_____

_____

b Have these been written down and made public (e.g. in an annual report)?

- O Yes
- O No

c Do they contain reference to the environment?

- O Yes
- O No

II ENVIRONMENTAL MANAGEMENT

07a What are your firm's three main environmental challenges?

1: _____
2: _____
3: _____

b What has your firm already done about them?
(mention recent projects)

_____
_____

08a Is management accounting of importance in meeting those challenges (see 07a)?
O Yes
O No

b Explain answer (either if yes or no).

_____
_____

09 To take up the above three environmental challenges (see 07a), different measures have been taken.
As far as these involved technologies, characterize them with the aid of the following matrix (tick relevant cells).

Production processes in the life cycle	Environmental technologies		
	Prevention	Reuse	End-of-pipe control
R&D			
Product design			
Production			
Distribution			
Use/consumption			
Disposal			

10a Do you believe that your firm's environmental challenges will substantially change over the coming years?
O Yes
O No

b If so, explain that change.

_____
_____

c If so, is that change relevant to the use of management accounting?
O Yes
O No

d If so (yes under c), explain.

_____
_____

III MANAGEMENT ACCOUNTING

PART A

11a Do you have currently management systems in your firm (in operation or being implemented)?
Give answer by ticking column 1 or 2.

Indicate the importance to environmental management of information generated by the management systems in operation or being implemented.

b as it is now (tick column 3, 5 or 7)

c as it will be in the future (tick column 4, 6 or 8)

Operational state			Importance to environmental management						Barriers
management system	1 in operation	2 being implemented	3 some now	4 some in future	5 considerable now	6 considerable in future	7 crucial now	8 crucial in future	9 yes or no
a quality management system									
a health and safety system									
a materials requirement planning system									
an environmental management system									
a management accounting system									
a process/job control system									
a financial accounting system									

d Indicate whether there are barriers in the use of the various management systems for the benefit of environmental management (write yes or no in column 9).

12 Explain the barriers indicated in column 9 (in table under question 8).

13 The systems you indicated as crucial (now or in the future) to environmental management (see question 8), how are they (or after implementation will they be) used in the field of environmental management? Give brief description.

14a Rank the following accounting functions according to their actual (now) and future usefulness to environmental management (opinion of the environmental specialist). Tick relevant cells.

	some		considerable		crucial	
	now	future	now	future	now	future
bookkeeping system (ledgers)						
operational budgeting: budget setting						
operational budgeting: budget control						
capital budgeting						
product costing						
performance measurement: financial						
performance measurement: non-financial						
other, namely _____						

14b Rank the following accounting functions to their usefulness to the management of environmental affairs *in the future* (opinion of financial controller).

	some	considerable	crucial
bookkeeping system (ledgers)			
operational budgeting: budget setting			
operational budgeting: budget control			
capital budgeting			
product costing			
performance measurement: financial			
performance measurement: non-financial			
other, namely _____			

15a As regards product costing, does your firm apply Activity Based Costing?
O Yes
O No

b Does your firm apply or intend to apply Activity Based Costing as a means to produce adequate environmental costs figures?
O Yes
O No

c In your firm, is there a felt need for more detailed information on environmental costs?
- O Yes
- O No

d If so, what has been its impact?
- O No measures yet, but there is a discussion going on about it
- O No measures yet, but there will be in the near future
- O Concrete steps have already been taken

e If concrete steps have been taken, explain what these involve.

_____

_____

f If concrete steps have been taken, how did your firm define environmental costs?

_____

_____

16 Do you believe that, in general, more attention to environmental issues within management accounting would reveal environmental costs higher than currently apparent and therefore encourage more pollution prevention or cleaner technology measures?

a Opinion of environmental specialist
- O Yes
- O No
- O No idea

b Opinion of the financial controller
- O Yes
- O No
- O No idea

17a Does your firm take into account the environmental costs of using or disposing of your product (after leaving the firm)?
- O Yes
- O No

b If so, explain.

_____

_____

18a Are external effects due to your firm's environmental behaviour taken into account when evaluating investment plans?
- O Yes
- O No

b If so, explain.

_____

_____

19 What external reports issued by your firm contain environmental costs data?

_____

_____

20 To what extent is the above data (see 19) derived from regular management accounting?

_____

_____

21a In external or internal reporting, is a distinction made between environmental expenditure and environmental costs?
- O Yes
- O No

b If so, how are environmental expenditure and environmental costs defined?

_____

_____

22 Does your firm have any environmental liabilities?
- O Yes
- O No

23a Has your firm created financial reserves with regard to future environmental expenditure?
- O Yes
- O No

b If so, for what kind of expenditure ?

_____

_____

_____

PART B

24 Does your firm use any of the following terms to categorize capital projects? (Check all applicable)
- O General/Administrative
- O Abandonment
- O Profit adding
- O Cost saving
- O Expansion of existing operations
- O Expansion into new operations
- O Profit sustaining
- O Maintenance
- O Replacement
- O Environmental
- O Compliance
- O Waste reduction
- O Pollution prevention
- O Waste treatment

25 At what level does capital budgeting occur in your firm? (Check all applicable)
- O Corporate
- O Division
- O Plant
- O Other (specify) _____

26 Is there normally a single budget pool for all capital projects, or do environmental projects (compliance and non-compliance) have a separate pool? (Check one only)
- O One budget pool for all capital projects
- O Separate budget pool for all environmental projects
- O Separate budget pool for compliance projects

27 Which of the following best describes the typical annual spending on environmental projects within your firm? (Check one only)

- O No set cap
- O Cap on total amount
- O Cap on % of total annual corporate capital budget
- O Varies from year to year

28 For each job function below, indicate if individuals are ROUTINELY involved in developing cost estimates for environmental projects. (Check all applicable)

- O Environmental
- O Finance/Accounting
- O Production/Operations
- O Purchasing
- O Legal
- O Vendors
- O Consultants
- O Other (specify) _____

29a Is your firm's environmental department involved in capital budgeting in general?

- O Yes
- O No

b If so, explain how

_____

_____

_____

30 Does your firm track environmental costs company-wide?

- O Yes
- O No

If so, at what level are environmental costs tracked? (Check all applicable)

- O Plant
- O Divisional
- O Corporate

31 Indicate whether INITIAL assignment of each of the following cost items is to an overhead account, or, alternatively, directly to a product, production unit, or process. (Check one answer for each cost item)

	Cost-item	INITIAL ASSIGNMENT IS ... Always to overhead	Usually to overhead	Usually to product/process	Always to product/process
a	One-site air/wastewater/hazardous waste	O	O	O	O
b	Testing and monitoring	O	O	O	O
c	One-site air emission controls	O	O	O	O
d	One-site wastewater pre-treatment/treatment/disposal	O	O	O	O
e	One-site hazardous waste handling (e.g. storage, labelling)	O	O	O	O
f	Manifesting for off-site hazardous waste transport	O	O	O	O
g	Off-site hazardous waste transport	O	O	O	O
h	Off-site wastewater/haz. waste pretreatment/treatment	O	O	O	O
i	Energy Costs	O	O	O	O
j	Water Costs	O	O	O	O
k	Licensing/permitting	O	O	O	O
l	Reporting to government agencies	O	O	O	O
m	Environmental penalties/fines	O	O	O	O
n	Staff training for environmental compliance	O	O	O	O
o	Environmental staff labour time	O	O	O	O
p	Legal staff labour time	O	O	O	O
q	Insurance costs	O	O	O	O

32a Indicate if the above costs (see question 31) are normally considered for inclusion in the financial analysis of a proposed investment project (mention codes): _____

b For which of the costs items normally considered, does your firm calculate a specific money value?
Mention codes: _____

33 Does your firm normally consider corporate image effects when deciding on environmental measures?
O Yes
O No

34 If some or all costs are initially assigned to an OVERHEAD ACCOUNT, do you later reallocate to a product or process?
O Yes (go to question 35)
O No (go to question 37)

35 In cases where your firm initially assign costs to an OVERHEAD ACCOUNT, what are the TWO most common cost drivers; or bases, for later allocating those costs to products/processes? (Check two)
O Labour hours
O Material use
O Square footage of facility space
O Production volume
O Other (specify) _____
O Not applicable – we do not allocate any costs to overhead

36 In cases where your firm initially assigns costs directly to a PRODUCT OR PROCESS, what are the THREE most common sources of cost information? (Check up to three)

- O Purchasing data
- O Materials tracking system data
- O Production/operation logs
- O Financial accounting system data
- O Product shipment manifest data
- O Waste shipment manifest data
- O Engineer estimate
- O Vendor estimate
- O Other (specify) _____
- O Not applicable – no costs are allocated

37 Prior to a detailed financial analysis of an investment project, does your firm typically perform a less detailed/informal screening of a project's profitability?

- O Yes ——→ Continue to question 38
- O Sometimes ——→ Continue to question 38
- O No ——→ Continue to question 39

38a What financial indicator is most commonly used in determining if an investment project passes the initial screening test?

- O Payback
- O Return on Investment (ROI)
- O Net present Value (NPV)
- O Normalized Net Present Value (Profitability Index)
- O Internal Rate of Return (IRR)
- O Return on Total Assets (ROTA)
- O Other (specify) _____
- O None, the evaluation is qualitative only

b Does that also apply to projects that are purely or predominantly environmental?

- O Yes
- O No

c If not, what in this case is the right answer?

_____

_____

39 For the full investment project justification, is there a standard hurdle rate, or threshold, required for project approval, which also include purely environmental projects?

- O Yes
- O No

40 For the full investment project justification, what financial indicator is most commonly used? (Check one only)

- O Payback
- O Return On Investment (ROI)
- O Net Present Value (NPV)
- O Normalized Net Present Value (Profitability Index)
- O Internal Rate of Return (IRR)
- O Return on Total Assets (ROTA)
- O Other (specify) _____
- O None, the evaluation is qualitative only

41a Is this financial indicator also applied to regulatory COMPLIANCE projects as well as NON-COMPLIANCE, or discretionary, projects in the environmental field?
- O Yes
- O No

b If not, what indicator is then applicable for environmental projects?

_____

_____

42a If your firm uses payback at any stage of project justification, what is the payback time period normally required for approval?
- O Less than 1 year
- O 1 - 2 years
- O 3 - 4 years
- O Greater than 4 years
- O We do not use payback

b Does that also apply to projects that are purely or predominantly environmental?
- O Yes
- O No

c If not, what in this case is the right answer?

_____

_____

43a If your firm uses Net Present Value (NPV), or normalized NPV, what is the time horizon typically used for calculating the NPV or Normalized NPV for an investment project?
- O 1 - 5 years
- O 6 - 10 years
- O Greater than 10 years
- O We do not use NPV or normalized NPV

b Does that also apply to projects that are purely or predominantly environmental?
- O Yes
- O No

c If not, what in this case is the right answer?

_____

_____

44a If your firm uses Internal Rate of Return (IRR), what is the IRR normally required for approval of investment projects?
- O Less than 10%
- O 10 - 19%
- O 20 - 30%
- O Greater than 30%
- O We do not use IRR

b Does that also apply to projects that are purely or predominantly environmental?
- O Yes
- O No

c If not, what in this case is the right answer?

_____

_____

45a If your firm uses Internal Rate of Return (IRR), what is the time horizon typically used for investment projects?

- O 1 - 5 years
- O 6 - 10 years
- O Greater than 10 years
- O We do not use IRR

b Does that also apply to projects that are purely or predominantly environmental?

- O Yes
- O No

c If not, what in this case is the right answer?

_____

_____

46 In general, how do the hurdle rates (i.a. threshold for approval) for environmental projects compare to those for non-environmental projects?

- O Hurdle rates are higher for environmental projects
- O Hurdle rates are the same for environmental projects
- O Hurdle rates are lower for environmental projects

INSTRUCTIONS

Management accounting
Management accounting is concerned with providing financial information to persons inside the organization, especially managers. It produces special purpose financial statements and reports. It is not required by law (such as financial accounting, in particular as regards the annual report) and it has no externally imposed standards. As an academic discipline it has developed broadly used methods in areas such as budgeting and costing

Environmental management
Environmental management is the management of the environmental affairs of a business. For that purpose, a firm has an environmental management organisation which determines the major division of tasks in the environmental field. Part of the job will be done by an environmental manager or adviser and their departments. Other elements of environmental management are integrated in the tasks and responsibilities of line managers, buyers and the like.
To control the entire process, firm may implement a stardard environmental management system that be certified and submitted to frequent audits.

How to handle this questionnaire
To fill out the questionnaire, two persons working with the firm need to be interviewed: the environmental specialist (manager or adviser) and the financial controller. It is advisable to introduce the survey to the firm via the environmental manager. Through him (or her) the controller is to be involved. The two may prefer to have one interview attended by both of them. In this way the survey contributes to bringing together two parties that very often live in different world. However, be careful that the interview observes certain time limits. Two hours are most likely needed. Take care that all three chapters are equally dealt with. Moreover, for each chapter it is advisable to first discuss those questions that can be answered by yes or no or by ticking relevant cells. Then go through the other questions that often involve further explanations. To be clear, these explanations are very important, but by following the above procedure it is prevented that part of the questionnaire cannot be dealt with altogether because of a lack of time.

Below, a few terms are explained in order to prevent interpretation problems. If the latter appear to hinder a satisfactory interviewing process, please contact the project co-ordinator.

07b
The environmental measures to meet the challenges may refer to areas such as
- waste management
- efficient use of raw materials and additives
- efficient use of energy
- added-on equipment such as air filters and water purification equipment
- internal recycling and reuse of water and materials
- external recycling of used products or packaging materials
- preventive technologies integrated into existing means of production
- substitution of materials
- ecodesign of the product
- equipment to measure and control emissions and discharges

09
The Environmental Technology Matrix should be read as follows. For each phase in the life cycle of a product (first column), the matrix indicates three kinds of technology: preventive technologies, technologies involving reuse (inclusive of recycling) and end-of-pipe control measures (second up to and including fourth column).

11

To be certain if the firm has got an environmental management system in case there is no standard system (such as EMAS or BS 7750) available, please consider the following. Major elements of a full-fledged environmental management system are as follows:

- an environmental policy plan (stating objectives and concrete measures for the coming years)
- assignment of environmental management task and responsibilities
- provisions for the training of staff in the field of environmental management
- measures and procedures to monitor the firm's environmental performance
- a procedure to evaluate the firm's environmental performance
- an audit programme
- a procedure to decide on corrective actions
- a management review involving adaptation of the environmental policy plan and the environmental management system itself
- environmental reporting.

If the environmental management system is not complete, but at least five elements are present (an environmental policy plan being one of them), the answer is yes (which can be combined with "being implemented").

14a and 14b

Operational budgeting involves the preparation of operating budgets. Capital budgeting refers to the preparation of investment plans. Performance measurement refers to the measurement of activities and serves to compare budgets with actual results.

Biographies

Matteo Bartolomeo has a Degree in Economics, and a Masters Degree in Environmental Management. He is a PhD student of Environmental Benchmarking at Erasmus University, Rotterdam. As a senior researcher at Fondazione ENI Enrico Mattei, Milan, Italy, he is currently working in the field of business and environmental issues. He is also the co-founder of an innovative research institute dealing with environmental management issues from a multidisciplinary perspective. He is the author of several publications, a member of the Expert Working Group on Environmental Accounting for UNCTAD-ISAR, and is also a member of the Editorial Board for the *Environmental Accounting and Auditing Reporter* and for the *Social and Environmental Accounting Newsletter*.

Martin Bennett is Principal Lecturer in Financial Management at the Business School of the University of Wolverhampton, UK; Research Leader of the Financial, Information and Operations Management Division; and leads the Environmental Management Accounting Group in the School's Management Research Centre. He was previously in the accountancy profession with KPMG and BDO Binder Hamlyn, in commerce with Great Universal Stores, and in education with Nottingham Trent University and Ashridge Management College. He researches, writes and consults on environmental management accounting and performance measurement, and publications (with Peter James) include:

- *The Green Bottom Line: Environmental Accounting in Business* (Greenleaf Publishing, UK, 1998);
- *Environment under the Spotlight: Current Practice and Future Trends in Environment-related Performance Measurement in Business* (Association of Chartered Certified Accountants, UK, 1998);
- *Environmental Performance Measurement and Reporting* (Greenleaf Publishing, UK, forthcoming in 1999);
- a substantial contribution to *Environmental Accounting in Industry: a Practical Approach* (British Telecom, ed. C. Tuppen, 1996).

He runs seminars and courses on environmental accounting and performance measurement at Brunel, Carnegie Mellon and Ghent universities, and is a member of the editorial board of 'Greener Management International' and of the Steering Committee of the *Environmental Management Accounting Network*, an international group of researchers.

Jan Jaap Bouma is a senior researcher at the Erasmus Centre for Environmental Studies (ECES) at the Erasmus University, Netherlands. He is a business economist and holds a PhD in environmental management. ECES is involved in research projects that focus on environmental management and its relationship with management accounting, to gain more knowledge about the shortcomings of current management accounting systems and develop techniques to achieve an adequate environmental management. Within ECES, a group of (business) economists work on adapting existing management accounting and designing new accounting systems and techniques.

Peter Heydkamp is an environmental scientist. Since 1978 he worked with IBM in different areas: facility engineer for environmental treatment plants; water programme-coordinator in a major IBM plant (Sindelfingen, Germany), whereby his main task consisted of solvent pollution investigation and clean-up; he was active in managing environmental projects, developing masterplans and evaluation impact assessments, as well as waste reduction programmes. Peter Heydkamp also was an user analyst for environmental software application development and marketing. For 3 years he belonged to the environmental staff for IBM Europe Central Region (Germany, Austria, Switzerland, and Eastern Europe), who worked on the implementation of common processes according to ISO 14000. Currently, he is corporate auditor and business controller.

Peter James is director of the Sustainable Business Centre, which conducts and disseminates research on how organisations can integrate sustainable development into their activities. It has particular expertise in the areas of environmental change management, environmental performance measurement, environmental benchmarking, and environmental accounting. Peter is also a Visiting Professor at Wolverhampton Business School and an associate of Ashridge Management College, where he was employed prior to founding the Sustainable Business Centre. Before joining Ashridge, Peter held positions at Stirling, Warwick and Limerick business schools, latterly as Professor of Management. He has published a number of articles on environmental benchmarking, environmental performance measurement and quality approaches to environment and was a co-author with Claude Fussler of *Driving Eco-Innovation* (FT Pitman, 1996).

Foppe de Walle received his doctorate in environmental engineering and was a faculty member at the University of Illinois in Urbana and Stanford University in Menlo Park. He is currently a faculty member at the University of Washington in Seattle where he teaches environmental technology in the Department of Environmental Health of the School of Public Health. He was director of 2 environmental institutes at TNO in Delft (the Netherlands) and is associated with ENERO, the European Network of Environmental Research Organisations. He is also scientific director of the consultancy firm Promikron BV in Delft. Prof. de Walle developed the environmental costing methodology as derived from the quality management models, with correction, failure and prevention categories. He also conducted numerous studies linking environmental quality conditions to required investments.He investigates and stimulates the introduction of advanced environmental technologies in manufacturing practices.

Teun Wolters is senior researcher and account manager at EIM Small Business Research and Consultancy in the Netherlands. He has been a researcher and consultant in the environmental field since 1991. Then he started research on environmental management and integrated chain management, which the Dutch government launched as a major tool of environmental policy. He also did work on environmental strategies in the following branches: paint & coatings, pulp & paper, construction and packaging. The last few years Teun Wolters was heavily engaged in two European projects, namely, the ECO-

MAC project (as project co-ordinator) on which this book reports and the ENVIS project (as contributing editor) which focused on the adoption of environmental innovations by SMEs. The ECOMAC experience is being used now to carry out a project on environmental management accounting in product chains which is sponsored by the Dutch Organisation for Scientific Research. Teun Wolters initiated the Eco-Management Accounting Network (EMAN) which had its second annual meeting in Rome, November 1998. Moreover, he is co-ordinator of a project geared at producing and marketing of sustainable coffee in the chain between Costa Rica and the Netherlands. Teun Wolters initiated the publication of several books in the Dutch language and co-authored several articles on subjects related to his research. He also is member of the editorial board of the journal *Business Strategy and the Environment* and lecturer of business environment as part of a management course of the Dutch Chambers of Commerce.

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