MARIA LAURA FRIGOTTO

UNDERSTANDING NOVELTY IN ORGANIZATIONS

A Research Path Across Agency and Consequences

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If more knowledge is the answer, what is the question?

This book is dedicated to G., who taught me the method,
To R., who taught me discipline,
To J., who inspired me to be passionate for knowledge.

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Introduction

The concept of novelty is central to organizations and organization studies. However, the scant number of contributions explicitly dedicated to novelty within the field (Garud et al. 2015; Padgett and Powell 2012; Rosenkopf and McGrath 2011; Levinthal 2008; Becker et al. 2006) provide a cue of the challenged understanding of this concept. To date, questions remain about the sources of novelty or the process through which it blooms into innovative products/services, creative outputs, unexperienced events, ex novo categories/concepts and imaginative interpretations, all of which are instances of novelty.

Garud et al. (2015) provided illustrations regarding the first and last of the aforementioned instances of novelty, without ambition of completion. They reported the well-known case of the 3M Post-it Notes, emphasizing the serendipitous discovery of polymers and the 12-year search for its application, as an example of an innovative product. They juxtaposed the unconventional case of the cutting-edge, multi-award-winning choreographer Wayne McGregor's improvisational practice in which dancers produce their own expressions of the general movements at each performance. Despite being taken from extremely distant contexts (i.e., the research lab of a company and the dance paradigm of an individual, and apparently not displaying any commonality), both cases

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illustrate novelty; namely, in the form of an innovative product and of a new imaginative interpretation of dance. In order to expand the reference points as well as to offer a more complete picture of diverse novelty, let us add some additional illustrations.

Novelty also appears in innovative services of which one of the recent and most challenging forms is the "uberification"[1] of services, which envisions the identification of consumer demand on mobile devices as well as the identification of supply providers among non-conventional industry members that can fulfill this demand through offline services. The typical case is the transportation system ranging from a carpool to a luxury car with driver, which has challenged the licensed taxi service system. Novelty can also be found in creative outputs, as in Moeran's (2013) account of the creation of a new line of faience tableware (i.e., the Ursula Series) that Ursula Munch-Petersen designed for mass production at the Royal Copenhagen Porcelain Factory. Disasters also display novelty, as in the prototypical illustration of the 9/11 terrorist attack cited by several authors (e.g., Cunha et al. 2006; Bazerman and Watkins 2004). Novelty also appears at the level of categories/concepts. For example, Jones et al. (2012) provided an analytical narrative of the generation and evolution of the ex novo category "modern architecture" between 1870 and 1975 in order to identify the architectural response to new functional needs and changing tastes, which were stimulated by the economic expansion, industrialization and urbanization of societies, and are characterised by the adoption of new materials such as reinforced concrete and steel.

The idea of a book on novelty stems from the consideration that several phenomena, such as innovation, discovery, creativity as well as new disasters, share the nature of novelty in diverse ways (Dunlap-Hinkler et al. 2010; Lagadec 2007; Westrum 2006; Quarantelli 1989; Boin and 't Hart 2007). However, a unifying discourse on novelty has not been attempted. Two reasons appear more clearly.

First, given the variety of novelty illustrations and the signs of the conceptual complexity of novelty, several scholars have prudently devoted their attention to other phenomena. As a matter of fact, complexity has been acknowledged by Rosenkopf and McGrath (2011), who claimed that novelty can be traced along several dimensions and

thus, it is a multifaceted phenomenon. More broadly, Garud et al. (2015) clarified that novelty has a different meaning under various philosophical traditions, particularly under ontological and epistemological terms. Padgett and Powell (2012, p. 1) explicitly indicated that a discourse on novelty is a discourse on something that is, by definition, difficult to understand. In this regard, they stated, "Something is not genuinely new if it already exists in our current practice or imagination". Becker et al. (2006) explained that novelty is "the thorny problem" of evolutionary studies and organization studies, representing the origin of change from the perspective of the adoption, diffusion and modification of such grains of change. Finally, Pigliucci (2008) categorised novelty among the "fuzzy" concepts, whose definitions and boundaries are not fixed and categorical but deployed in terms of degrees that change in relation to contexts and conditions.

The phenomenological and conceptual complexities of the topic, however, are not the only reasons why novelty has marginally been considered, despite its centrality for the theories and practices of organizations. As second reason, an accurate observer could argue that, while novelty per se has been poorly addressed in the organization literature, it is possible to identify several studies that share an interest in the origin of innovation (or the motivation for new emergencies) and indirectly address novelty. However, taken together, such studies provide a picture on our current understanding of novelty, which is biased in at least two ways.

First, a unified discourse on novelty has not been attempted since novelty has not been considered a proper unit of analysis. Instead, previous studies have limited their focus on individual instances of novelty in order to be more delineated and analytical. Thus, although independent contributions have been developed and some studies have tried to disentangle novelty, for example by addressing the antecedents of innovation (or the early signals of new disasters), a connection between them still needs to be established.

Second, within the independent contributions, the studies have only addressed a subset of the novelty instances. For example, the literature on economics and management operated a double selection. On the one hand, scholars focused on novelty that leads (at least potentially) to

success and positive consequences (Becker et al. 2006), while only considering the negative downsides as accidental implications. On the other hand, novelty has been typically deemed worth considering in terms of the results of individual/organizational will and determination (Padgett and Powell 2012). In this regard, the interest is based on the possibility of designing the novelty. Additional studies have acknowledged emergent novelty, which is not designed nor pursued (e.g., Cattani 2006; March 2006; O'Mahony and Bechky 2008); however, its inclusion has been limited among the sources that organizations might use to strategise. As another example, the literature on emergency management operated an opposite but still biased selection. Scholars focused on unprecedented emergencies (e.g., the 9/11 terrorist attack) which display a kind of novelty that is not designed and that can lead to negative outcomes (e.g., Weick and Sutcliffe 2001; Lagadec 2007; Boin and 't Hart 2007). In this regard, the interest is based on the possibility of taming the novelty.

Given this picture, a tentative discourse on novelty is a significant challenge. However, the challenge is raised in this book, considering the centrality of the issue for theory and practice as well as the biased picture that the extant literature is providing on the phenomenon. It also builds on the consideration that novelty is not an analytical concept; however, this does not diminish its prominence. In addition, an accurate definition and a thoughtful understanding are still possible, in terms of degrees (rather than binary expressions) and a higher level of abstraction in which individual peculiarities are either abandoned or synthesised into conceptual dimensions.

This book proposes a framework that establishes the basis for setting an inclusive discourse on novelty across diverse literatures and peculiar phenomena. It organises unity along two dimensions that create a matrix where the novelty types are positioned. The first dimension is related to the consequences of novelty, which may be positive or negative. The second dimension refers to intention and control. In this regard, novelty is generated intentionally through designed and controlled activities, and it also emerges from evolutionary dynamics through actions/interactions that are not intentional, programmed or controlled. Through this framework, this book identifies and compares

the results from two main categories: (1) *black* novelties, which include new disasters, emergencies and hazards that typically appear as unexpected events; and (2) *white* novelties (novelties with positive consequences), which include innovation, invention, discovery and creativity.

The recognition of a unique matrix for different phenomena helps elaborate on the dimensions that build novelty across instances, understand their individual peculiarities and reflect on the latency of those that are not prevalent. This also supports a better understanding of both novelty and the parent concepts (i.e., the individual instances) as well as identifies the dimensions of novelty. Second, such common nature sets the basis for cross-fertilization of knowledge developed for various instances of novelty. Third, under the unifying concept of novelty, divergent contributions find reasons for being related, which gives rise to multidisciplinary research.

Strategy and organization scholars have often shared the efforts typical of "organizational and social engineers [that] seek ideas about possible organizational forms or governmental procedures [or strategies] that might affect the rate of novelty or the success rate of novelty (Nootebloom and Stam 2008)" (March 2010, p. 95). The attempts to find early ways to distinguish and select successful novel ideas has not produced clear working solutions, at least in regard to radical novelty, which has subsequently changed the state of the art considerably. There are several reasons why critics of this approach would explain the state of such results. For example, selection is typically based on "conventionality" or "normal" knowledge, which is (by nature) unable to capture disruptive novelty and its potential, or more radically, the possibility of imagining ex-novo novelty sounds pleonastic.

In this book, some implications are derived from this author's understanding of novelty, all of which can be offered to organizations. The criticism towards this perspective increases the motivation to address novelty as the subject of focus. In addition, the way in which engineering is included in this book is not towards increasing the design/control of a novelty and its result (which is, by definition, inappropriate), but towards supporting spontaneous generation in the context of limited resources and towards capturing its sprouts.

Finally, this book adds to the literature on innovation and emergency management by offering a unique review of contributions on innovation and new emergencies. However, more ambitiously, it increases the possibility of unifying the literature on novelty. In particular, there are two meta-contributions of this work. First, the positioning of the discourse on innovation and creativity on the positive side of novelty draws attention to the core of the generative process, which includes both great innovations and sound failures. This book attempts to reset the balance between success and failure (or opportunity and threat) as well as between design and emergence in our understanding of the dynamics of novelty generation. Second, the organizations find themselves on the border between the design and emergence of novelty. This book also aims to answer the following questions: To what extent is it possible to engineer the emergence of novelty? What does this mean in terms of organizational design and strategies? How can organizations increase their exposure to and enhance their ability to recognise emergent novelty?

Book Organization and Chapter Overview

This book is organized into three parts. The first section addresses novelty within evolutionary theories and organization studies. The second part develops a framework for novelty in organizations, where novelty is constructed as deriving from both design and emergence (i.e., novelty is planned and unplanned), and it produces negative and positive consequences or *black* and *white* novelties, respectively. Finally, the third part provides a primer on novelty and presents strategies and structures for engineering novelty generation.

1.1 Part I: Novelty from the Background to the Spotlight

CHAPTER 2: Novelty in Evolution

This chapter addresses the core of evolutionary theories searching for the concept of novelty, given that it has been typically assumed, rather than clearly affirmed. Despite the fact that the evolutionary perspective is not the only viewpoint available in organization studies, it has fruitfully served as a unifying factor for the diverse theories on organizations

(Stoelhorst 2008; Aldrich and Ruef 2006; Durand 2006). In addition, it builds on the natural perspective when addressing change and its complementary phenomenon; that is, novelty (e.g., Pigliucci 2008; Fontana 2001; Nelson and Winter 1982; Hodgson 2005; Hodgson and Knudsen 2006). An in-depth investigation of the evolutionary theory and its developments allows one to clarify the nature and peculiarities of novelty, as stated in biology. It also allows one to discuss how they adapt or differ in the context of organization studies. This approach is important for distinguishing the original conceptions of novelty from the ideas resulting from the inclusion of the evolutionary perspective in organization studies, especially since a univocal and unique viewpoint has not emerged as clearly dominant. In other words, an important way to improve clarifications is to discuss how evolutionary theories in biology have been included in the social sciences, and how this has impacted the actual understanding of novelty. In fact, there is some confusion regarding some aspects of novelty and change, such as the role of randomness, the role of intent in human action, the role of random variation and purposeful adaptation. This makes it difficult to grasp the extent to which emergence and design are responsible for the generation of novelty, which is essential for developing principles for their engineering. In sum, this chapter positions the discourse on novelty within evolutionary theories of organizations, and discusses the critical question regarding the role of purposeful action versus randomness, the latter of which will build part of the framework for understanding novelty; that is, design versus emergence.

CHAPTER 3: Novelty in Organization Studies

Chapter 2 includes an analysis and a discussion regarding the role that the main perspectives in the organization studies have shaped for novelty. Given that no stream of research has concentrated on novelty as its focal interest, the collection of disperse contributions concerning novelty may help build an overview of the state of knowledge on this topic. The result is a positioning of the approaches to novelty in organization studies, according to two elements: the endogenous and/or the exogenous conception of novelty, and the main level of analysis adopted for this investigation. The details regarding what constitutes novelty in each specific model is also offered.

1.2 Part II: A Framework for Novelty

CHAPTER 4: Novelty across Consequences and Control

This chapter presents the framework proposed in this book to understand novelty. The framework builds on the idea of novelty as a unified phenomenon, which can be understood along the two dimensions presented below. Traditionally, such dimensions have partitioned rather than specified novelty in the literature. Here they are used to identify novelty types that have individually been tackled in the literature. The two dimensions are as follows:

1. Consequences: novelty can provide positive and negative consequences. In the first case, novelty is typically addressed in terms of innovation, invention, discovery and creativity, whereas in the second case, novelty is addressed in terms of disasters, emergencies and hazards.
2. Intention and Control: novelty is intentionally generated through designed and controlled activities. However, it also emerges from evolutionary dynamics and from a set of actions/interactions that is not intentional, programmed or controlled.

By plotting these dimensions, a typology of novelty is built in which the novelty types are positioned, which may be intended as pure cases of the phenomenon or ideal types à la Max Weber.

CHAPTER 5: *Black* Novelties and the Early Recognition of Emergence

In this chapter, novelty is considered in terms of new disasters, emergencies and hazards (i.e., novelty associated with effective or potential negative consequences), all of which appear without being designed or planned. This chapter also builds on the literature on organizational learning in the field of emergency management, and presents several labels to discuss novelty such as “rare emergencies”, “black swans”, the “unexpected” and the “unthinkable”. Each label draws attention to different “nuances” and “properties” of novelty, and to the challenges they pose for organizations that attempt to deal with them. Here, novelty represents a threat to human life as well as to natural and artificial

resources. The challenges for organizations concern the possibility of anticipating novelty or recognising it early enough to fruitfully mitigate its impact or possibly avoid it altogether. Building on empirical evidence and theoretical literature on new emergencies (by passing through the various labels), this book raises such a challenge by discussing both the competencies and learning strategies adopted by organizations to support the early recognition and defence in this field. The discussion will particularly refer to the case of the 9/11 terrorist attack in New York.

CHAPTER 6: *White* Novelties and Their Capture

In this chapter, novelty is associated with potential positive consequences. While such novelty is strongly pursued by organizations, which design it and set up plans for its production, this chapter focuses on innovation that is not designed, but found. This chapter builds on the contributions that have attempted to shed light on the dynamics of emergent innovation by reflecting on the role of open innovation systems such as broadcasting and crowdsourcing, which allow to find solutions that are ill-defined and as such are not fully defined and targeted. However, the roots of "emergence" in innovation and strategy trace back to groundbreaking contributions such as Mintzberg (1978) and Mintzberg and Waters (1985), in addition to more recent efforts on interesting concepts such as serendipity. In this chapter, novelty represents an opportunity that organizations want to seize. Building on empirical evidence and theoretical literature on invention, innovation, and creativity, it discusses what strategies are available to organizations in their efforts to recognise and capture novelty.

1.3 Part III: A Primer

CHAPTER 7: A Working Definition and Tentative Models

This chapter collects the theoretical contributions illustrated in Chaps. 5 and 6, and builds a working definition of novelty. In addition, the dimensions of novelty variability are specified, and illustrations and examples of novelty are reported. This is designed to help the reader build an analytical understanding of the novelty category. Then,

it explores two models that provide an abstract representation of novelty: the NK landscape model (Kauffman 1993; Levinthal 1997) and the network model. The first model represents the relativity of novelty through the coexistence of global and local optima, while the second model allows one to represent the surprising nature of novelty (as unknown unknowns).

CHAPTER 8: Organizational Implications and Conclusions

This chapter collects the strategies illustrated in Chaps. 5 and 6 for the early recognition of emergent novelty. It refers them to the models introduced in the previous chapter and explains how they represent working strategies to reach novelty. Starting from such strategies, the implications for organizations are derived in order to design organizations that are more inclined to include or skip emergent novelty; that is, early recognition enables an organization to avoid or strongly mitigate the novelty. These considerations build a set of suggestions for engineering novelty not by controlling it, but by designing greater exposure and inclusion of emergent novelty.

Note

1. The word refers to Uber, an American online transportation network company. Uber offers transportation by connecting demand and supply of transportation through a web application. In fact, consumers submit a trip request through the Uber app, and the software programme alerts the Uber driver nearest to the consumer. Uber drivers use their own personal cars and do not own any kind of taxi license.

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Part I

Novelty from the Background to the Spotlight

2

Novelty in Evolution

2.1 The Quest for Attention

Novelty is a central phenomenon in organizations and a central construct in theories on learning, change and adaptation. In evolutionary theories, novelty has been referred to as the implicit "lifeblood" (Levinthal 2008, p. 98), since it is the motivation for learning, the source of change and the reason for adaptation. As Witt stated: "For a proper notion of socioeconomic evolution, an appreciation of the crucial role of novelty, its emergence, and its dissemination, is indispensable" (Hodgson 1995, p. 473). However, it is also the ancestral "thorny problem" (Becker et al. 2006). Darwin never truly answered the question about the origin of change, and novelty remained excluded from the focus of evolutionary theories (Padgett and Powell 2012). With such a gap in the theory, early critiques of Darwin pointed out the difficulty of accounting for the new characters that appeared, as a result of variations and mutations (Muller and Wagner 1991). Moreover, the inability to define the nature of novelty appeared to some as a problem that challenged the entire theory. The quest for a deeper understanding of novelty is as old as the formulations of theories about the evolution of organisms (Winter 2004),

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and it is central to them, both conceptually and methodologically. However, it is far from being satisfactorily understood.

Historically, evolutionary studies have focused on adaptation and selection; that is, they focused on the change occurring from one state to another, rather than on the novelty stimulating change. This preference has resulted in a view of evolution that emphasised kinematics (i.e., the study of how things move or change), instead of dynamics (i.e., the study of why things change) (Fontana 2001). In addition, the questions concerning why and where the material of evolution emerged were relegated to the borders of the theory (Pigliucci 2008).

In line with the evolutionary perspective as such, the main stream in the social sciences has adopted Darwin's approach (Nelson and Winter 1982; Simon 1962; Hannan and Freeman 1989), and it has developed and diffused an "adaptionist program" that has largely prevented the analysis of novelty (Levinthal and Rerup 2006, p. 98). In fact, a consistent part of the literature in organization studies has investigated selection and reproduction within adaptation (Argote 2013; Argyris 1982; Cyert and March 1963; Hedberg et al. 1976; Levitt and March 1988; March and Olsen 1998; March and Simon 1958), whereas the processes regarding the emergence of novelty have remained widely unexplored.

In biology, jumps in evolution, which can be related to breakthrough novelty, are mainly referred to as "mutation". However, in the social sciences, since Schumpeter, who unsuccessfully searched for patterns and regularities in disruptive change, mutation has been more the "label for the inexplicable" (Becker et al. 2006, p. 357), rather than an explanation of the generation of novelty. In the literature on organizations, while some dynamics are sketched, an understanding of breakthrough novelty generation—that is, mutation—is still far to come. At the most, the main source of novelty has been considered as recombination (Levinthal 2006), even if it has been associated with several instances that differ in scope and nature, which has resulted in a confusing, if not inconsistent, picture.

A recent growing interest on the origins of change and on emergence, rather than on evolution and diffusion, has appeared both in biology (see the so-called evo-devo stream of research) and in the social sciences (e.g., Padgett and Powell 2012). In particular, in the social sciences,

it has been striking to clarify the role of agency and how it challenges (or is compatible with) evolutionary theories. This focus can correspondingly illuminate our reasoning on the role of design and emergence.

This chapter addresses the core of evolutionary theories searching for conceptions of novelty that are typically assumed rather than clearly stated. Despite the fact that the evolutionary perspective is not the only viewpoint available in organization studies, it has fruitfully served as a unifying perspective for the diverse theories in organization (Stoelhorst 2008; Aldrich and Ruef 2006; Durand 2006). Moreover, it is the natural perspective when addressing change and its complementary and originating phenomenon; that is, novelty. A deeper investigation within the evolutionary theory and in its developments clarifies the nature and the peculiarities of novelty (as stated in biology), and to discuss how they adapt or differ in the context of organization studies.

This approach is important in order to distinguish the original conceptions of novelty from the ideas that resulted from the inclusion of the evolutionary perspective in organization studies, especially since such a process did not result in a univocal and unique viewpoint. In other words, an important passage for improving clarification is the discussion on how evolutionary theories in biology have been included in the social sciences, and how this has impacted the actual understanding of novelty. However, there is some confusion on several aspects of novelty and change, such as the role of randomness, the role of intent and will in human action, and the role of random variation and of purposeful adaptation, all of which make novelty the result of uncontrollable forces or the result of design. This makes it difficult to understand to what extent emergence and design are responsible for the generation of novelty, which is essential for a reasoning of their engineering. In fact, this chapter considers whether novelty is derived from randomness or purposeful planning in order to address what role emergence and design may have in novelty generation. Within evolutionary studies in the social sciences, this question has traditionally been translated into the question of to what extent novelty is the result of learning or selection; that is, if novelty is more related to a Lamarckian or Darwinian conception of novelty. This point is not just speculative, but it has important implications on the possibilities of generating novelty and controlling

its production. For instance, if novelty is mainly related to evolutionary change and selection, then what is the role of organizational intent and design in this picture?

2.2 Novelty in Darwin's and Lamarck's Theories

"Evolution refers to the development of a form—an organism or other unit—from a simpler to a more complex or advanced state (*Shorter Oxford English Dictionary 2003*, Vol. 1: 876)" (Child 2012, p. xiv). The word comes from the Latin word *volvere*, meaning "to roll", which provides the idea of motion (Hodgson and Knudsen 2006b). However, the focus of evolutionary research has been on how the development occurs, and how novelty has been assumed. According to Child (2012, p. xiv), there is "a pre-existing form from which evolution proceeds [that] contains the rudiments of the parts of the evolved form". As such, novelty is both the ingredient and the result of adaptation. In other words, novelty is the material on which natural adaptation is built, and the effect of adaptation to specific environmental conditions. These two levels are closely connected, and they appear as two levels at which novelty can be considered: *Type A*, the *ingredient* novelty; and *Type B*, the *result* novelty.

Evolutionary literature has mainly addressed how the result of adaptation—Type B novelty—was provided by evolution. The focus is on the result of evolution, and typically, theories provide explanations of how a species has evolved into its observed condition. It is possible to identify two main explanations of evolution: the so-called Lamarckian and Darwinian explanations. They have animated the debate since their introduction, and they still build the main reference points for contributions in the evolutionary perspective. In biology, the debate as to how evolution of organisms occurs has centered on Darwin's theory of natural selection (Darwin 1859). Conversely, in the social sciences, whether the evolution of organizations follows a Darwinian or a Lamarckian perspective still stimulates lively discussions, and it is still the subject of open debate. Both of these perspectives need to be considered for understanding how organizations interact with their environments and

the consequences of such interaction for their evolution (Child 2012). They are also important for the purpose of this book—the understanding of novelty in the organizational realm—since they illuminate the issue of novelty on two aspects.

First, despite that it is not the purpose of these theories, by explaining evolution, it also explains how (Type B) novelty is provided as a result of such a process. In fact, novelty is the complement of change; that is, it is other side of the same coin since it provides the novel element that combines with the existing one (Levinthal 2008). As such, evolutionary theories illustrate how novelty survives and affirms itself. Second, even though it does not directly address novelty, by explaining change they reveal a concept of novelty, accounting for its role and motivation for change (Type A).

Lamarck (1809) viewed evolution as learning, and believed that organisms change over time from simple to complex forms that are more suitable for the environment in which they live (Child 2012). His thesis claimed that organisms transmit to their offspring the characteristics that they develop during their lifetime. Such characteristics are the result of environmental adaptation. In this perspective: (1) novelty is *nurtured*, that is, generated over a lifetime by the more frequent use of features that are best suited to the environment (or their disuse); and (2) novelty is *inherited*, that is, it is passed on to the next generation.

Darwin (1859) maintained evolution as selection. The best-suited organisms that survive under certain environmental conditions have greater possibilities to pass on their given characteristics to the subsequent generation. These organisms will mate more often and their offspring will be stronger, thus increasing their chances of survival. From this perspective, organisms that derive from evolution are determined by the environment, which selects those that will survive and those that will become extinct through the variation-selection-retention (VSR) model. In this regard, there are three aspects to note (Smith 1993; Mayr 2001): (1) novelty identifies with the continuous production of variation concerning the *natural* uniqueness of each organism; (2) such variation is passed on to the offspring; and (3) there is a natural selection operating on such variation, after which only some organisms are retained. In other words, variation bestows a higher survival rate on organisms, and as a result, they will have

a higher possibility of generating larger offspring that diffuse these beneficial variations into the entire species. The main sources of novelty and variety include (Hodgson 1997, p. 406): meiosis, that is, the recombination of genetic information of parents in sexual reproduction; and mutation, that is, damages, errors, insertion or deletion of segments of DNA. Such variations appear without any purpose and in absence of a cause that can be captured in present models or through available knowledge.

At the time when Lamarck and Darwin offered their contributions, neither molecular biology nor genetics had been considered. Accordingly they mainly based their theories on observations of morphological traits.[1] Both of their theories have been integrated and corrected in light of the development of certain disciplines (Pievani 2009). The concepts of genotype and phenotype have been used to discuss the differences between the Lamarckian and Darwinian perspectives, claiming that, at the core of the theories, there is the idea that novelty is phenotypic in the first perspective, while it is genotypic in Darwin's perspective. However, recent studies have shown that the picture is more complex. Thus, the challenge for research is not simply discarding one and adopting the other.

Since the theoretical and experimental work of August Weismann (1893) excluded the possibility of inheriting acquired (phenotypic) characters by human organisms, Lamarckism, as a general explanation of evolution, has been overshadowed in modern biology. Weismannism or neo-Darwinism is a contemporary perspective in biology, often confusingly labeled as "Darwinism", thus acknowledging genotypic variance as the only basis of evolution (Hodgson and Knudsen 2006b; Child 2012). This perspective helped establish the concepts of Lamarckism and Darwinism as irreconcilable opposites (Hodgson and Knudsen 2006a, b). However, Darwin (1859) never dismissed the idea of phenotypic adaptation and its inheritability. In addition, recent studies in biology have recovered the Lamarckian idea of phenotypic adaptation to the environment as complementing genotypic-based evolution. As a reference for this discussion, Table 2.1 presents the essential definitions in evolutionary theories.

Table 2.1 Evolutionary perspectives on novelty

	Lamarckism	Darwinism	Weismannism or Neo-Darwinism	Darwinian pluralism
Main reference	Lamarck (1809)	Darwin (1859)	Weismann (1893)	Gould (2002)
Evolutionary mechanism	Learning	Selection	Selection	Learning and selection
Type A novelty	Acquired variation through frequency of use	Natural variations: no influence or control through behaviour	Natural variations: genetic encoding; No genotypic inheritance of phenotypic characters	Both acquired and natural variations: developmental encoding
Type A novelty "reframed"	Phenotypic novelty	Genotypic novelty	Genotypic novelty: meiosis and mutation	Both: Genotypic novelty: meiosis and mutation; Phenotypic novelty: phenotypic plasticity, epigenetic, behavioural novelty
Type B novelty	Biodiversity of extant species			

2.3 The Sources of Novelty in Contemporary Evolutionary Biology

While several issues are still strongly debated, different perspectives in evolutionary biology share a Darwinian core, where natural selection is acknowledged to be, by far, the main mechanism of change (Pievani 2009), but not the exclusive one. Other causes also play a role, even if scholars diverge in their assessments of their relevance. The perspective that allows several possible causes to jointly explain evolution is labeled as "Darwinian pluralism" (Gould 2002). While the debate is rich and articulated, at least three main findings need to be considered.

First, research in biology has clarified that not all traits are only defined by the genotype. In fact, organisms adapt to their environments through phenotypic plasticity; that is, "the capacity of a single genotype to exhibit a range of phenotypes in response to variation in the environment" (Whitman and Agrawal 2009, p. 1). In other words, organisms accumulate silent genetic variations that can be activated in particular cases of environmental stimuli or stress. It has been shown that such traits influence subsequent evolution (Whitman and Agrawal 2009).

Second, epigenetics[2] clarified that genes build a complex network that reflects both the interactions and their structural proximity. Although the interactions of such genes build the phenotype, there are different ways to connect and position genes so that they may provide the same function. For example, a protein can be codified by several genes, and vice versa, genes can be responsible for generating several proteins. This opens to variations that are not genic but *epigenetic*, meaning that the change does not alter the genotype, but its activity. Such variations are relevant for evolution since research has shown that they are inheritable.

Third, another still disputed "add-on" to the Darwinian perspective that recalls the Lamarckian position is the so-called Baldwin effect. Baldwin accounted for variations in behaviour that affect survival and reproduction rates. Suppose that a species is threatened by a new predator and there is a behaviour that makes it more difficult for the predator to kill individuals of the species. The individuals who adopt the behaviour more quickly will obviously be at an advantage. Such behaviour is

then passed on to the next generation through imitation and maternal instruction (not through genetic inheritance). Through this process, the behaviour becomes a part of the instinct or the culture of the species, which directly impacts their survival and reproduction rates.

In sum, the architecture of knowledge on evolution relies on a Darwinian core. However, the research on phenotypic plasticity and epigenetics has significantly expanded the thinking about organic evolution (Pigliucci 2005, p. 491). In this light, biological novelty originates at the level of genotypes, phenotypes, epigenetics and behaviour. Thus, evolution and novelty rely on a plurality of causes. Randomness and mutation are just some of the engines of change and the sources of novelty.

In light of the available studies, the two perspectives are therefore definitely complementary, rather than alternative (Hodgson 2013; Hodgson and Knudsen 2006a, b, 2010; Child 2012), and the debate regarding whether evolution is, in nature (or nurture), seems to be, in some sense, idle and outdated. Notwithstanding that the core of evolutionary theories is Darwinian, it is now equally clear that the environment plays a fundamental role in defining how evolution is deployed, within the range of possibilities structured and regulated by genes. In addition, the idea of the relationship between genotypes and phenotypes has moved away from the genetic blueprint (or genetic programme) that defines linear (or quasi-linear) mapping between genotypes and phenotypes. Rather, the concept of "developmental encoding" (as opposed to the classical one of genetic encoding) (Pigliucci 2010) seems to better capture genotypic changes as well as the interplay between genes, which is responsible for the development of features or parts (epistasis).

The "evo-devo" stream of research (formally known as "evolutionary developmental biology") studies the role of gene interactions in the production of novel features, such as feathers (Prum and Brush 2002), rather than gene modifications. Moreover, they recognise that the structure and function of genes set a "topology of possible" novelties and evolutionary paths (Fontana 2001) that may occur. This topology defines the proximities and interactions and builds another ingredient for novelty that can be switched on over time. Accordingly, they

Table 2.2 Essential definitions and novelty sources in evolutionary theories

Genotype	"The set of genes of an individual; its genetic constitution" Durand (2006, p. 14).
Phenotype	"The total of all observable features of an individual (including his/her anatomical, physiological, biochemical, and behavioral characteristics) resulting from the interaction between the genotype the individual inherited and the environment s/he encounters" Durand (2006, p. 14).
Lamarck's evolutionary theory tenets	Environmental alterations—felt needs—new habits—use and disuse—acquired characters Liagouras (2013, p. 1281).
Darwin's evolutionary theory tenets	Variation—inheritance (replication)—selection and retention (interaction) Liagouras (2013, p. 1281).
Genome	The totality of genes carried by a single gamete Durand (2006, p. 14).
Gamete	A male or female reproductive cell (e.g., spermatozoon or egg) that carries half of the organism's full set of chromosomes (in sexual reproduction) Durand (2006, p. 14).
Meiosis[a]	"A special kind of cell division that occurs during the reproduction of diploid organisms to produce the gametes. The double set of genes and chromosomes of the normal diploid cells is reduced during meiosis to a single haploid set. Crossing-over and therefore recombination occurs during a phase of meiosis" Ridley (2004, p. 686).
Recombination[a]	"An event, occurring by the crossing-over of chromosomes during meiosis, in which DNA is exchanged between a pair of chromosomes. Thus two genes that were previously unlinked, being on separate chromosomes, can become linked because of recombination, and vice versa. Linked genes may become unlinked" Ridley (2004, p. 688).

(continued)

Table 2.2 (continued)

Mutation[a]	"When parental DNA is copied to form a new DNA molecule, it is normally copied exactly. A mutation is any change in the new DNA molecule from the parental DNA molecule. Mutations may alter single bases, or nucleotides, short stretches of bases, or parts of or whole chromosomes. Mutations can be detected both at the DNA level or the phenotypic level" Ridley (2004, p. 686).
Phenotypic plasticity[a]	"The capacity of a single genotype to exhibit a range of phenotypes in response to variation in the environment" Whitman and Agrawal (2009).
Epigenetics[a]	Area of biology that studies the causal interactions among genes that build the phenotype; such interactions are inheritable and do not change the sequence of the DNA Waddington (1942).
Baldwin effect[a]	"The effect that learned behavior can have on evolution." "If learned behavior has a substantial effect on reproductive success or on fitness in general, a predisposition to learn the behavior and to benefit from it might be selected for" Wikipedia.
Epistasis[a]	"An interaction between the genes at two or more loci, such that the phenotype differs from what would be expected if the loci were expressed independently" Ridley (2004, p. 684).

Note Highlighted with [a] the multiple sources of novelty

understand that novelty first *emerges* and then *becomes available* for evolution *when* it occurs within a "topology of possible" interactions among genes. Therefore, while the relative role of development, selection, and genotypic transmission is still disputed in biology, the debate animated by the evo-devo research has established that development, selection and genotypic transmission are intertwined and inseparable

processes. As such, they should be included among the sources of novelty. Table 2.2 highlights the multiple sources of novelty that are recognised in biology (with a star).

2.4 The Inclusion of Evolutionary Theories in Organization Studies

Beyond the misunderstood contraposition between the Darwinian and Lamarckian perspectives, it is still discussed whether and how evolutionary theories can illuminate social phenomena. Darwin (1859, 1971) considered that his theory would be used to explain change in language, morality and social evolution (Hodgson 2005). In this regard, two factions can be identified: those who are against the inference of evolutionary biology in the social sciences (e.g., Dugger 1981; Fracchia and Lewontin 1999; Liagouras 2013; Brown 2012), and those advocating such inference. Among the latter are the supporters of "Generalised Darwinism" (Hodgson 2005, Hodgson and Knudsen 2006a, b, 2010; Aldrich et al. 2008; Stoelhorst 2008), who produced extensive and accurate arguments in favour of their perspective.

The core of the debate concerns the possibility of broadening the explicatory power of Darwinian concepts from biology (Lewontin 1970) to different domains and levels of life (Hodgson 2002). On the one hand, some authors (e.g., McKelvey 1982; Shepherd and McKelvey 2009; O'Mahoney 2007) adopted evolutionary concepts to build theoretical interpretations of the social phenomena by drawing analogies. On the other hand, Generalised Darwinists argued that Darwinism should not be imported into the social sciences as a precise and peculiar explanation for those dynamics and thus, one should speculate on the equivalent of meiosis or a gene. The details of socio-economic evolution may differ from biological evolution. In addition, since the Generalised Darwinists agree that the Darwinian framework is not enough to explain life in complex systems, they require the development of specific and ad hoc theorizing (Hodgson

2013). However, Generalised Darwinists also claim that, at a higher level of abstraction, evolving systems share an "ontological communality" (Aldrich et al. 2008, p. 579) that allows Darwinian tenets to describe evolution within a wide variety of domains (Campbell 1965; Hodgson 2003; Hodgson and Knudsen 2004; Hodgson 2005; Stoelhorst 2008).

At the heart of this higher-level framework are the principles of variation, selection and retention as well as the concepts of interactors and replicators (Hodgson 2002; Hodgson and Knudsen 2010; Aldrich et al. 2008).[3] An interactor is "an entity that interacts as a cohesive whole with its environment in such a way that this interaction causes replication to be differential", while a replicator is "an entity that passes on its structure largely intact in successive replications" (Hull 1989, p. 96).

Several attempts have been made to deploy the interactor and replicator distinction. Some authors have viewed routines as replicators (Aldrich and Ruef 2006; Hodgson and Knudsen 2004; Nelson and Winter 1982) to the extreme they have been considered as "*the* organizational replicator" (Warglien 2002, p. x). Conversely, there is more divergence in the identification of relative interactors; that is, actions performed in light of a routine (Breslin 2008) or how firms provide a locus of change for replicators through interactions with other replicators (Hodgson and Knudsen 2004). Others have seen artefacts (typically technological artefacts) as interactors, and ideas, knowledge (Murmann 2003) and techniques (Mokyr 2000) as replicators. Furthermore, replicators have been recognised (Warglien 2002) in the following: double interacts (Weick 1969), comps (McKelvey 1982), rules and procedures (Levitt and March 1988) and strategies (Axelrod and Cohen 2000).

Hodgson and Knudsen (2006a, b) found that replicator/interactor identification was critical for distinguishing between imitation/contagion and replication/inheritance (Breslin 2011). This distinction reveals that "true retention", which requires the copying of the knowledge and capacities underlying the routine, only occurs in the second case (Aldrich et al. 2008). As such, the replicator/interactor identification defines two different levels of depth in which novelty builds

organizational life, and two different dynamics of transmission to the offspring.

However, for the acceptance of Generalised Darwinism, the interactor and replicator concepts have been particularly problematic (Nelson 2006). In fact, extant empirical evidence has been able to provide only a poor understanding of this "true retention"; that is, when and to what extent the reproduction of an action implies the acquisition of its knowledge base is arguable. Moreover, in the spirit of the Generalised Darwinian approach, such a distinction is only necessary if justified by empirical grounds in the field (Nelson 2006), which Hodgson and Knudsen (2006a, b) indicated. When this is lacking, the identification of replicators—for example, in routines—seems to follow the thoughts of analogical speculation more than those of empirical specificity revealing evolutionary dynamics. As a result, the same issues emerge as those of validity.

The field of social sciences still lacks a clear, empirical grounded theory regarding the link between what they identified as replicators and interactors, as there is in biology between genotypes and phenotypes. As a result, the validity of this interpretation needs further assessment and empirical investigation. Moreover, the issue whether routines are interactors or replicators, and if these two concepts are actually meaningful for the social realm, remains fundamentally inscrutable, thus requiring further empirical evidence (Nelson 2006).[4]

Finally, the social sciences display some peculiarities whose consistence and implications have not yet been completely grasped. For example, inheritance in social systems implies an active role of the replicating entity that differs from the passive attitude of an offspring inheriting the parents' genes (Liagouras 2013). An investigation of such peculiarities has also been suggested by Generalised Darwinists, as details of the socio-economic evolution. However, they cannot assess whether these details should be consistently included in the framework and how they would change the Darwinian classical perspective.

2.5 Darwinian or Lamarckian Evolution in the Social Sciences?

In general, evolutionary theories have been used in organization studies to build a broad framework for understanding change. In many studies, the term *evolution* is used with some "gravitas", as if it meant something important. However, without further specification, this meaning quickly vanishes when attempting to understand the concept (Hodgson 2013, p. 974). Only recently, the debate has pushed towards a more careful specification regarding the nature of the evolutionary perspective (Lamarckian vs. Darwininan), which has sometimes assumed a challenging/provoking character (Durand 2006; Hodgson and Knudsen 2006a, b, 2007; Nelson 2007; Aldrich et al. 2008; Hodgson 2013; Liagouras 2013).

Comparatively, few studies have cited Lamarck with respect to Darwin (Hodgson and Knudsen 2007). However, several of the most prominent social scientists have adopted the Lamarckian view to describe socio-economic evolution. Actually, evolutionary theories have been introduced and understood in economics and management through the book by Nelson and Winter (1982), in a way that is more Lamarckian than in most evolutionary theories in biology (Cyert and March 1992, p. 224). Moreover, as other eminent bearers of such perspective, Hodgson and Knudsen (2006a, b) mentioned Simon (1981), McKelvey (1982), Hirshleifer (1982), Boyd and Richerson (1988), Hayek (1988) and Robson (1995). As such, a Lamarckian perspective of socio-economic evolution has become more popular (Hodgson and Knudsen 2006a, b, 2010), even if it is unclear whether these authors, by mentioning Lamarck, also meant to exclude the Darwinian perspective on evolution (Hodgson and Knudsen 2006a, b). For example, a later debate (Nelson 2007) clarified that, in Nelson and Winter (1982), the Darwinian perspective was meant to be implicit (Hodgson and Knudsen 2010, p. ix).

The debate is also accurate when addressing the adoption of labels. As stated in Sect. 2.3, recent developments in biology support a pluralism of causes that jointly explain evolution. In biology,

such pluralism has labeled as "Darwinian", the main evolutionary dynamics of natural selection. However, the adoption of a similar label in the social sciences would not be justified by the same empirical ground. However, in the social sciences, the role and the relevance of selection and adaptation is so highly debated (Nelson 2006; Breslin 2011; Liagouras 2013; Hodgson 2013; Hodgson and Knudsen 2010; Aldrich et al. 2008) that some have provocatively suggested substituting Darwinism with Lamarckism in every label (Liagouras 2013). At the present state of research, social evolution is undoubtedly both Darwinian and Lamarckian (Levinthal 1991; Amburgey et al. 1993; Amburgey and Singh 2005), regardless of the label that is adopted. In this regard, addressing the prevalence of one or the other is more an exercise of the mind than evidence of the facts.

2.6 Common Misunderstandings on Evolution and Novelty

This passionate debate is the result of the fact that, simplistically, the Lamarckian and the Darwinian evolutionary explanations have been imported into organization theories in the form of a debate regarding "whether the forms that organizations take are the outcome of environmental selection or of adaptation resulting from strategic choices made by organizational decision makers" (Child 2012, p. xv). Such debate concerns the entire evolutionary process of variation, selection and retention, and it is mirrored in the idea of novelty as randomly generated or purposefully pursued. However, this perspective reflects two misunderstandings about evolutionary theories that have spread in organization studies (Durand 2006; Aldrich et al. 2008). In fact, the underlying conceptualisations of evolution and the related use of the Lamarckian and Darwinian labels are only loosely grounded in the actual work of these authors (Durand 2006; Hodgson and Knudsen 2006a, b, 2010).

First, Lamarckian and Darwinian theories have been represented as opposite, rather than complementary, mechanisms of evolution (Hodgson and Knudsen 2006a, b), building on the concept of blind versus intentional evolution. This false opposition is based on the following trains of thought (Durand 2006): (1) Darwin's theory allows for variation, as a random endowment of nature, and it places all explanatory power in environmental selection; and (2) Lamarck's theory conceives evolution as a process of intentional and intelligent adaptation to changes occurring in the environment. Typically, contributions favouring one or the other side develop their arguments at two different levels of analysis (Child 2012). For example, Darwinists focus on entire populations of organizations and investigate the economic and institutional features of a particular environment that push organizations towards conformity. Such pressures are unavoidable and non-negotiable for organizations. Conversely, Lamarckians focus on individual organizations and on decision/routine behaviours in particular, to live, adapt and creatively change their environment. As experience accumulates, their common tendency is to retreat on consolidated ways of performing certain actions. In addition, the very notion of strategy is premised on the ability to proactively intervene in the environment (Child 2012; Abatecola 2014; Cafferata 2010; Durand 2006; Dagnino 2006).

Second, the acceptance of evolution, as designed progress and improvement, is widespread in management (Durand 2006). As a result, the inevitability of progress towards something good is taken for granted (Solari 1996). In addition, inserting the organism's evolution in this path of inevitable progress is what "intelligence" attempts to achieve.

As for the first misconception, the Lamarckian and Darwinian perspectives build an integrated framework to understand evolution in which both elements of variation, given in nature or acquired during lifetime or through culture, are included. In addition, Darwin never denied intentionality or intelligence (Hodgson and Knudsen 2006b). In his view, intentionality and intelligence were both part of evolution and the result of the same evolutionary process (Hodgson and Knudsen 2006a). As Durand (2006) indicated, it is possible to refer some

elements of organization theories to Darwin or Lamarck, but it is normal that the theories include both.

As for the second misconception, the notion of the "survival of the fittest" is often mistakenly interpreted as conveying progress in evolution (Stoelhorst 2008) and the positive role of selection that only retains good and useful novelties (Gould 2002, p. 139). This was originally introduced by Herbert Spencer, not by Darwin, since he never saw evolution as progress. Nevertheless, this conception was labeled as "Social Darwinism" (Durand 2006). Moreover, the idea of evolution as progress also acquired an inevitability character. Since the first adoption of the word "*evolution*" by the German biologist Albrecht von Haller in 1744, it has been "associated with a specifically directional and predestined" final status (Hodgson and Knudsen 2006b, p. 2); that is, the final "natural step in an historical path" (March 1994, p. 39). The first adoption of this word regarded the changes of the human embryo into a complete human being (Hodgson and Knudsen 2006a; March 1994). Originally, evolution meant change towards greater capabilities, elaboration, beauty and being environmentally fit (March 1994). Evolution is often seen as a set of developments, which are "unfolding toward a destiny that is implicit in the unit that is developing or in its environment or both" (March 1994, p. 40). They also portray such evolution as the invention of human actors that typically follow their rational choice. Contributions illustrating the elaboration of technologies from vague ideas to well-shaped and profitable products (or narratives celebrating the life of great entrepreneurs or historical heroes) reflect this conception of evolution (March 1994, 2010; March and Weil 2005).

In sum, it is useful to remove two common misunderstandings on evolution, which might also be transferred to novelty. Novelty in evolution should not be conceived as deriving either from selection at the system level, which organizations cannot impact, or intentionality at the organizational level; rather, it stems from both of these dynamics. In addition, novelty does not convey evolutionary progress along a designed path, even though this vision has widely grounded the perspective on evolution in the social sciences. I will discuss alternative conceptualisations of evolution and of novelty in the subsequent sections.

2.7 Blind and Intentional Variation

Although Herbert Spencer introduced Darwin's evolutionary VSR model in 1898 to study organised systems, which is also responsible for several misunderstandings that are still being shed (Aldrich and Ruef 2006), one of the most widely diffused models of sociocultural evolution is the VSR model developed by Campbell (1960, 1969) (Romanelli 1999; Durand 2006). In this regard, variation concerns the availability of diverse manifestations, selection concerns "the differential elimination of certain types of variations", and retention concerns the preservation, duplication or modified reproduction of selected variations (Aldrich and Ruef 2006, p. 17). Variation, selection and retention are useful starting points for understanding evolution (Aldrich and Ruef 2006), rather than analytical categories for describing evolution.[5] However, within this model, an interesting distinction has been drawn which is useful for understanding novelty.

Campbell distinguished between *intentional* and *blind* variation. Intentional variation "occurs when people actively attempt to generate alternatives and seek solutions to problems", while blind variation "occurs independently of conscious planning" (Aldrich and Ruef 2006, p. 17). The dualism of the Lamarckian and Darwinian views described in the previous sections is reflected in the duality of these concepts, which is responsible for the generation of emergent or designed novelty.

In favour of blind variation, Campbell (1969, p. 81) stated: "Too often, in contemporary social science, analysis stops when it is traced back to individual motives, as though these were the prime movers, the uncaused beginning of causal sequences", due to the neoclassical conception of decisions resulting from the determinateness of fixed preference functions (Hodgson 1997, p. 407). However, "design emerges without a seeing designer" (Vanberg 2004) (Hodgson and Knudsen 2006b, p. 11) that plans it at a higher level (March 1994).[6] This also downsizes the role of a superior designer as well as the limitedly rational decision-making individual.

In a later contribution, Campbell affirmed the equal value of blind and deliberate variations. On the one hand, it is possible to argue that "deliberate" or "intelligent" variations are better than blind variation, since they can be pre-selected. On the other hand, Campbell (1987) added that, if deliberate variation was the only one or the predominant one, then the future would be very limited, since humans do not dispose of all of the necessary knowledge to design their future, and their knowledge is path dependent. In fact, their capacity of foresight reflects acquired knowledge and experience (Romanelli 1999), and it is restricted to the implications of previously achieved wisdom (Campbell 1965, p. 28). For example, when genuine innovations are assessed, humans are unable to define their probability of success or failure since they did not acquire the knowledge to do so (Hodgson and Knudsen 2006b, p. 11).

For Campbell (Durand 2006, p. 62), blind variation is the most plausible version of evolutionary variations, since "blind variations surpass human individuals and agencies" (Campbell 1969, p. 74).[7] In an even stronger perspective on the poor role of intentional human action, blind variation occurs through mistakes and accidental learning (Levinthal and Rerup 2006). As such, on the one hand, novelty deriving from blind variation should be understood in terms of novelty potentially providing greater impacts (both in the positive and negative sense), since it is not subject to human limited knowledge and understanding of reality. It could also be "wiser" than intent, since it provides adaptive challenges that are unforeseen or unwanted by rational agents. Studies that could be mentioned within this logic include the garbage can decision model of Cohen et al. (1972) or the change dynamics in the population ecology perspective of Hannan and Freeman (1989). On the other hand, the higher potential of the blind type of novelty also concerns higher risk, since novelty, which is hardly included in organizational knowledge, is also rarely perceived and adequately managed. In addition, it will most likely end up being inconclusive and dispersive.

Finally, Campbell did not use the term *random* to qualify variation, since he did not want to confuse the precise process of randomization in statistics with the less precise variation dynamics (Aldrich and Kenworthy 1999, p. 22). Instead, he preferred the term *blind* or

haphazard to highlight the absence of "self-conscious planning or foresightful action" (Campbell 1965, p. 28). He also stressed that the theory of evolution does not necessarily require being entrusted to "self-conscious planning or foresightful action", since it would be severely limited from agents' present knowledge and from the possibility of building more knowledge.

2.8 Emergence

2.8.1 Meaning and Operationalization

Blind variation in the Campbellian theory of evolution finds expression in the phenomenon of emergence (Van de Ven et al. 2008). According to Seidel and Greve (2016, p. 2), emergence is an easily understood and intuitive concept, meaning the act of something coming into existence or appearance. The word *emergent* was first suggested by Lewes (1875), who distinguished between "resultant" and "emergent" compounds produced through chemical reactions (Hodgson 1997; Garud et al. 2015, Chap. 1). A "resultant" compound can be predicted from its chemical components, while an "emergent" compound is irreducible to its component parts. Morgan (1927) introduced the concept of emergence to the theory of evolution to account for discontinuities that introduce novelty and change into the evolutionary process. He also explained that, in the adjective *emergent*, "the emphasis is not on the unfolding of something already in being but on the outspringing of something that has hitherto not been in being" (Morgan 1927, p. 112, quoted in Hodgson 1997, p. 405). In organization studies, the concept of emergence is well established (Garud et al. 2015), as in the notion of emergent strategy (Mintzberg and Waters 1985), which facilitated a deeper appreciation of the unplanned change in practices and processes of strategising over deliberate planning (Chia and Holt 2009).

Like blind variation, neither blindness nor emergence is meant to be a synonym of randomness. Nevertheless, the diffused association

of emergence with randomness derives from and can be intended as a first attempt to operationalise the concept. In fact, referring emergence to randomness is equal to making at least one of the following two assumptions (Van de Ven et al. 2008): (1) that the source of novelty is external to the system under scrutiny; or (2) that the source of novelty is internal, but its factors and dynamics are unidentifiable and impossible to relate in terms of patterns of relation. These refer to two different views, which are often confused under the umbrella labels of "emergence" and "blind variation". At this point, let us consider them one at a time.

If emergence is an *exogenous* phenomenon (i.e., Case 1), as Feyerabend explained, then the temptation is to think that the definition of a lower micro- (or higher macro-) level of analysis and the identification of the elements at that level may entirely explain the emergent properties (Hodgson 1997). Such reductionism, however, may fail to achieve complete satisfaction and, as a result, may proceed without an end. In this view, emergent novelty is exogenous. Conversely, in the second assumption (i.e., Case 2), emergence is considered to be *endogenous*, and novelty is due to an "uncaused cause", which is the manifestation of the indeterminateness of evolution; that is, it embodies "the self-transforming" "of a system over time through endogenously generated change" (Hodgson 1997). This distinction is useful for grasping the different stances on emergent novelty in the literature and provides a clear and simple framework for categorising studies; thus, it will be adopted in the next chapter. In fact, for the purposes of simplicity and convention, when reviewing the literature, the distinction between endogenous and exogenous emergence will be maintained.

However, a more fine-grained observation of evolution shows that endogenous and exogenous novelties are often difficult to isolate and that limiting our definition of emergence to a distinction between exogeneity and endogeneity might be simplistic. On one hand, the distinction between endogenous and exogenous emergent novelty provides structure to our understanding. However, on the other hand, it responds more to our need or tradition of scientific

research (i.e., setting levels of analysis and focusing on what occurs at each level, while everything else is "on hold") than to the nature of the phenomenon. Hodgson (1997, p. 404) claims that if we were to start with the phenomenon, then we would argue that parts, wholes, individuals, systems and institutions "mutually constitute and condition each other, and none has analytical priority", and that one should "accept multiple levels of analysis, each with their own partial autonomy".

Despite its apparently intuitive meaning and simple and useful operationalisation, emergence has a complex nature that derives primarily from the several different and unrelated views on it that coexist.

2.8.2 Emergence Within Different Causal Frameworks

With respect to emergence, different people understand things in different ways, resulting in distinct and very different epistemological and philosophical positions. Clarifying these perspectives by distinguishing how the world is conceived and how causality is intended may help to sort out the different meanings and conceptions of emergence (Stacey et al. 2000; Garud et al. 2015, Chap. 1).

The framework offered for understanding different positions builds on Stacey and colleagues' (2000) causal framework. The first distinction we need to introduce is whether we consider, as Prigogine (1997) suggested, the future to be given or to be under perpetual construction. In other words, the world can be either determined or undetermined (i.e., it can produce either determined or undetermined outcomes). The other variable comprises the outcomes of action and evolution (Facchini 2008).[8] These include optimal arrangements, sub-optimal outcomes, and moving outcomes that stress the system's continuous and unstoppable transformation, according to which there is no (meaningfully identifiable) end state. These two dimensions serve as the basis for Table 2.3.

Three causal frameworks seem the most relevant for our discourse. The first of these is the natural law framework, within which the world proceeds towards determined outcomes according to the laws of nature.

Table 2.3 Emergence and novelty in different causality frameworks

Causal frameworks	Determined world	Undetermined world	Outcome	*emergence*	*novelty*	*examples*
Natural Law framework	*x*		Optimal arrangement	None: emergence is apparent and temporary, will be removed by knowledge discovery	None: there is correction rather than novelty along the process of "getting laws right"	Organizations in scientific management
Formative framework	*x*		End form	Emergence concerns actor's search paths only	"pre-determined" novelty	Organizations in systems theory; NK models in strategy
Transformative framework		*x*	Continuous and transformed form	Emergence is continuous and concerns both the sphere of actor's knowledge and the world	Undetermined genuine novelty	Complexity theory, actor-network theory

Here, there is no room for emergence as it derives from uncaused causes. Emergence exists only in the eyes of the human agent who needs to discover all of the laws of nature and whose expectations do not reflect these laws completely. However, emergence is temporary and a product of human limits and human time, though it does not exist as such. Novelty is temporarily exogenous, meaning that it lies beyond the attention of the agent but is gradually included in his consideration as his knowledge and understanding of the world progresses. Within this framework, we can position scientific management's views of organizations or strategic management's rationalist view (e.g., Gavetti and Levinthal 2000).

The second framework of interest is the formative framework, according to which the world originates from the interaction of elements from the micro to the macro and ends in pre-determined possible end states. However, the path that is actually taken depends on interaction and is not designed in advance. Here, novelty appears as the result of unknown laws and processes but reflects a hidden order that needs to be discovered. Emergence exists in terms of paths, not outcomes, which are pre-determined. This perspective on emergence can be illustrated in the way in which Kauffman's NK models have been imported into organization studies (Ganco and Hoetker 2009): solutions are given on the landscape, but paths are defined by organizations. Other agent-based models, such as the Schelling (1969) segregation model, also display this conception of emergence.

Third, the transformative framework proposes that the world originates through interaction and that there is no end state or range of possible outcomes that can be selected; instead, possibilities are open and indeterminate. From this perspective, emergence is continuous, generative and transformative. All elements of interaction play a role in co-creating reality. Novelty is, therefore, unknown and undetermined for both the single agents, who cannot gain the system perspective, and the system, which evolves to unknown states. Novelty derives from an uncaused cause and can only be understood through several levels of analysis; however, an understanding of the past does not provide direct knowledge on how the future will unfold. The Actor-Network Theory (Callon 1986; Latour 1987) displays this kind of emergence and novelty.

2.9 Agency

As described in the previous section, there are at least three different frameworks within which emergence can be understood and which display different assumptions concerning causality and dynamics. Now, the relevant question for the social sciences is: Within these frameworks, and in relation to emergence, what room is there for intentionality and human decision? In other words, how does blind variation interact with intended variation?

As stated by Campbell (1965), blind variation does not imply the absence of conscious choice or deliberate decision. Instead, agents adopt intelligent strategies to make decisions in contexts in which they are unable to accurately predict the outcomes of their actions (Romanelli 1999; Bradie 2001; Simonton 2011). In other words, they build internally coherent interpretations of the situation, despite being unable to assess the truthfulness or external validity of these interpretations (Frigotto and Rossi 2015). These intelligent strategies lead agents through events in the absence of an overview of the system's dynamics. The resulting intelligent decisions derive from blindness (Durand 2006). In this sense, *blind* is not a synonym for *random* (meaning that the variations are "uncaused"); rather, it is used in the sense that the variations display no connection to the agent's design, understanding or plan, even if the agent him/herself may play an active role in the performance of such variations (Ruse 1986, p. 80; Simonton 2011, p. 160).

Aldrich and Ruef (2006, p. 18) noted that sociologists and organizational scholars often interpret the interaction between intentional and blind variation in terms of *agency*. They also understand this link in terms of whether actors are free to make autonomous decisions and, as the result of a good mapping of actions into consequences, are able to choose the consequences of their actions.

However, the issue of agency is not limited to variation. For example, selection is traditionally differentiated into external selection, which concerns "forces external to an organization that affect its routines and competencies", and internal selection, which concerns "forces internal to an organization that affect its routines and competencies" (Aldrich and Ruef 2006, p. 17). This distinction carries the implicit and general

implication that, while human agents can control and design internal forces, they have a more difficult time impacting external forces. A more precise approach considers whether an agent (or an organization) has or can develop a project/design through which he/she may try to control such external influences. Similar considerations can be built with respect to retention. More generally, the issue of agency concerns the extent to which intention is involved through the variation, selection and retention process, especially in terms of the possible measures of control and design over its various components and dynamics.

Table 2.4 illustrates how agency combines with emergence and to what extent human agents can play a role and exert influence within the different causal frameworks.

In natural law causality, actors' actions involve trying to comprehend the laws of nature in order to make various elements fit and align with these laws. Actions can be intentional and purposeful, since an actor can exploit natural laws to reach chosen goals. Within this framework, the future is knowable, and actors can act upon it. Consequences follow a more or less hidden order, which it is the actor's duty to unveil. Time is irrelevant for the system, as nature and its laws are eternal and the future is a repetition of the past; however, time exists for actors until they complete their knowledge. In this framework, if the chosen goal is not reached, the failure is a reflection of the agent's imperfect knowledge.

In formative causality, actors' actions consist of trying to define a satisficing search path within a world on which actions have no influence. Actions can be intentional and purposeful, as the actor can search for and select among solutions to realise chosen goals. Solutions are designed at the system level, where the actor cannot act; however, they can still be reached. Time exists for the actor only, who spends his time searching in a chosen direction and because he forgets previously uncovered solutions over time. In this framework, if the best goal is unlikely to be reached, this is a reflection of both the agent's choice of a wrong searching strategy and his lack of knowledge.

In transformative causality, the actor plays an active role in the formation of the world, and not only in its discovery or exploration. Intention and control are potentially better expressed here because the system has no determinate parts; rather, the system is built by several

Table 2.4 Agency in different causality frameworks

	Action	Can agent's intention control and design the outcome?	Future	Time
Natural Law framework	Effort of "getting it right", aligning, fitting	The actor can exploit natural laws to reach chosen goals	KNOWABLE FUTURE: discover hidden order; if-then rules	Time is irrelevant at the system level: past, present and future are the same Time exists for the actor until he completes his knowledge
Formative framework	Effort of defining a satisficing search path, the actor cannot impact on the definition of the world	The actor can search solutions and select among them to approach chosen goals	KNOWABLE FUTURE: search and select good solutions among already designed outcomes	Time exists for the actor who decides to spend time to search in some direction and because he forgets distant solutions
Transformative framework	Effort of participating into the formation of the world	The actor can impact on the formation of the world, and can try to direct it towards chosen goals	UNKNOWABLE FUTURE: solutions form over time through interaction	Time plays a role for both the system and the actor

interacting forces, which the actor must take into account in order to reach his goal. With respect to the possibility of actually reaching goals, the management discourse has been too simplistic in claiming that managers can choose strategic directions for their organizations. In fact, managers' choices are limited by the fact that other managers are trying to influence both them and the dynamics of their interaction in order to foster their own selected goals. In other words, what emerges is not the product of the simple choice of one manager, but, rather, is related to the conflicting constraints that several managers place on one another (Stacey et al. 2000, p. 117). In this framework, time is also relevant for the system, as it articulates the perpetual construction of the future. In fact, the future is unknowable in nature, as it takes form through continuous interaction without a range of pre-defined possibilities. In this framework, if a goal is not reached, it is likely due to the system interactions producing an evolution very different from those produced in the past, which builds the basis for the agents' system of knowledge and expectations. Here, novelty is due not to the agents' limits, but to the nature of the system.

Notes

1. Darwin (1859) wrote that the eye of the evolutionist should distinguish superficial analogies, appearing since two organisms share the same environment (e.g., they live in the water), from deep homologies (i.e., ancestral physical structures that two organisms share) to reveal a type of kinship (Pievani 2010).
2. In 1942, Conrad Waddington used the term *epigenetics* to describe the area of biology that studies the causal interactions among genes that build the phenotype. Such interactions are inheritable, and they do not change the sequence of the DNA.
3. Some authors adopting the VSR framework referred to the term *Universal Darwinism*, coined by Dawkins (1976). Hodgson (2005) noted that, while Generalised Darwinism refers to this idea of a higher-level framework based on an ontological similarity among systems of life, Universal Darwinism has typically been associated with a "gene-centered view of biological evolution" (Breslin 2011, p. 220).

4. In an attempt to solve this issue, Winter proposed broadening the replicator concept entrusted to routines to "quasi-genetic traits" in order to identify any traits displaying enough stability to accumulate feedback from the environment (Cohen et al. 1996).
5. It is not easy to use these categories analytically. For example, considering variation, it is difficult to empirically identify instances of variation, the reason of which is twofold. First, according to the level of analysis adopted, some instances may be considered as both instances of variation and selection. In general, "variation operates at a component level", while selection "operates at macro-levels" (Durand 2006). Examples of selection are the diffusion of variations between social groups, the imitation of individual practices, and the definition of education programmes as well as rational decision-making principles (Durand 2006). However, by changing the level at which the observer considers evolution, some instances may be considered elements of variation or selection. For example, from the perspective of populations, phenotypical plasticity provides variation, whereas in a study on the genotype-phenotype link, it is the result of selection. Second, variation, defined as the availability of diverse manifestations, can hardly be separated from selection or retention. In fact, variation does not only concern an initial stage of evolution in which it is self-contained and isolated. Conversely, variation is embedded in selection and retention through the transformation occurring in the entire evolutionary process. This is the reason why this book did not identify novelty with evolutionary variation. To illustrate this point, consider, for example, the case of routines. Routines change when they are performed. Thus, they produce variation by nature; but they can also be considered as the result of the process of selecting alternative possible routine performances. In sum, the VSR model can be used analytically with some caution, and novelty concerns changes appearing as variations and also as transformations appearing through selection and retention.
6. As Cafferata (2009) noted, theories of evolution are not necessarily against the existence of a creator that is identified with God. Evolutionary theories do not need to conceive the existence of God to justify the existence of organisms and the universe. However, they leave open the possibility of the existence of God in a twofold sense. The first concerns the *sense* of the existence of organisms and the universe, while the second concerns the *modus*; that is, the way in which the creation may have occurred that is nowadays explained "in many and complex ways (Martini, C.M. 2009, 9)" (Cafferata 2009, p. 52).

7. Another way blind variety occurs is through mistakes and accidental learning (Levinthal and Rerup 2006).
8. Stacey et al. (2000) interpret this in terms of the reason for moving into a future that is determined or undetermined. They interpret the causality framework as classifying different kinds of teleology. Teleology is the branch of philosophy concerned with the "why" question—that is, why do organisms exist the way they do?—and that builds answers by assuming that organisms exist in a certain way because they serve a certain purpose or realise a certain goal. The concept of teleology is controversial in evolutionary studies because it almost exclusively assumes an Aristotelian stance, claiming that purposes and goals are defined by a final cause that, since Thomas Aquinas, has been interpreted as God. Referring primarily to Darwin, several scholars in biology have chosen to exclude teleology from the scientific realm and confine it to metaphysical discourses. Stacey et al. (2000) introduce teleology in their framework because they build it from the perspective of the human actor, whose behaviour is purposeful in nature. By contrast, I will introduce considerations of the human actor's role and perspective in the section where I address agency. Here, I retain the framework as a structure for a broader reasoning of causality, which is related to an agent's external intentionality, which, in the Christian teleological approach, is God, or to his internal functionality, or efficient cause, which is the outcome of non-purposeful and unintentional natural selection.

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3

Novelty in Organization Studies

3.1 Explanatory Dimensions and Categorization Criteria

This chapter presents an overview of the main perspectives in the organization studies literature shaping novelty. Since no stream of research has yet focused primarily on novelty, this review builds on the collection of contributions that can be easily applied to novelty. In the previous chapter, we argued that novelty is primarily an implication of change and that our evolutionary stance provides the natural framing for an understanding of novelty. Aldrich and Ruef (2006) reviewed six streams of research in organization studies along an evolutionary perspective, through which they distinguished the Darwinian, Lamarckian and Spencerian (referring to Herbert Spencer [1820–1903]) foundations. We adapted the scope of these streams according to our more specific focus on novelty. They are: (1) population ecology; (2) neo-institutionalism; (3) evolutionary economics; (4) dynamic capability theories and the resource-based view; (5) organizational learning and (6) organizational cognition.

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The review is built along three dimensions. As the first element of categorization, we consider the following levels of analyses adopted by such theories: population, organization and individual. In organization studies, theories typically develop their explanations at only one main level.

Second, organizational evolutionary approaches vary according to whether they emphasise exogenous, endogenous or combined sources of organizational evolution. Thus, exogeneity and endogeneity are assessed by answering the following question: "Is the variable causing change inside or outside of the system?" (Hodgson 1997, p. 408, emphasis removed) For several reasons illustrated in the previous chapter, this distinction can sometimes appear artificial. However, such distinction is maintained as it is well accepted and provides a clear initial representation of how organization studies approached novelty.

Third, for each stream of research it is identified what they intend for Type A novelty and for Type B novelty—respectively the "ingredient" and the "result" in novelty (see Chap. 2). Through the illustration of the relationship between the Type A and Type B this chapter will also provide a comment on what role these streams entrust to agency and emergence.

Finally, in regard to the misunderstanding illustrated in the previous chapter (Sect. 2.6), researchers often classify contributions as Lamarckian when they describe novelty generated through learning and imitation; that is, it is the result of the intentional design of one generation. Conversely, they label contributions as Darwinian when they describe novelty generated from previous actions as "being inherited" (e.g., Van de Ven and Grazman 1999, quoted in Durand 2006, p. 74) and resulting from competitive selection. Roughly speaking, novelty that is derived from natural selection is related to Darwin; novelty that is derived from directed will is associated to Lamarck. In the following sections, building on Durand's (2006) and Aldrich and Ruef's (2006) analyses, this book traces back the relationship between theories and their references to the evolutionary approaches in a more accurate way with the aim of clarifying the role they agency, intentionality and control.

This chapter provides a general overview of the positions towards novelty within organization studies. It is clear that, within the variety and articulation of studies that belong to a certain stream, there

Table 3.1 Novelty in evolutionary organization models

Organizational model	Source of novelty*	Novelty A type	Novelty B type	Level of analysis
Population ecology (PE)	exo	Variations in environmental sources, political conditions, institutional movements	Organizational actual condition: heterogeneity of organizational forms	Set of organizations: "populations"
New/neo-institutional (NI)	exo	1. "jolts": variations occurring at the periphery of the institutional field	Organizational actual condition: homogeneity of organizational forms and behaviour	Set of organizations: "field" (also: individual, group, organization, system)
	endo	2. Interpretation of ambiguity by professionals (scant)		
	exo	3. External variations		
	endo	4. Institutional entrepreneur and process dynamics		
Evolutionary economics (EE)	exo-endo	Changes in environmental resource endowment and firm abilities (routines) with respect to (exo) technological trajectory Gradients of novelty built on performance change	Organizational variety	Set of organizations: industries and Firms
Resource-based view (RBV)	exo-endo	Environmental resource endowment and managerial choices building an (endo) technological trajectory	Resource control and rent appropriation	Firms

(continued)

Table 3.1 (continued)

Organizational model	Source of novelty*	Novelty A type	Novelty B type	Level of analysis
Organizational learning (OL)	exo-endo	Adaptive learning perspective: history as filtered by organizational attention and interpretation	Learnt behaviours/ increased knowledge	Within organizations
		Knowledge development perspective: structure and strategy designed for knowledge development	Innovation/efficiency	
Organizational search (OS)	exo-endo	Local and distant search, exploration and exploitation Gradients of novelty built on cognitive distance	Innovation	Within organizations, organizations and Firms
Organizational routines (OR)	endo	Organizational routine dynamics	New or modified routines	Within organizations: Routines
Organizational cognition (OC)	endo	Discrepancies, ambiguities	New sensemaking organizational schemata or framing	Within organizations, organizations and Individuals
		Incomplete or distorted set of decision elements: unexpected events, decision biases and deviations	Post-mortem inclusion of new decision elements	

Note exo: exogenous, *endo*: endogenous

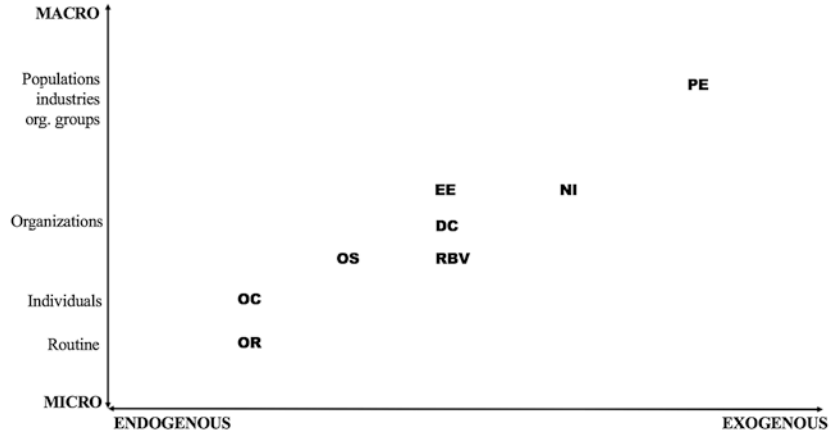

Fig. 3.1 Mapping of organization models on novelty

might be contributions that depart from the mainstream, but would be particularly relevant for our understanding on novelty. However, the readers might be surprised to not find them here, based on two explanations. First, this categorization effort concerns streams in the organization studies literature with all of the necessary simplifications (as well as limitations) that such an exercise requires. Second, unless certain studies are oriented towards the entire stream or towards a certain stance on novelty, individual contributions are more duly included in the following chapters. Table 3.1 and Fig. 3.1 illustrate this categorization.

3.2 Population Ecology (PE)

Population ecology (PE) addresses the evolution of populations of organizations by attempting to explain their diversity (Hannan and Freeman 1989). While sharing a common dependency on material and social environments, sets of organizations ("populations") (Hannan and Freeman 1984) display various forms of survival rates. Three factors account for such dynamics in the PE explanation (Hannan and Freeman 1989; Carroll and Hannan 2000). First, environmental resources are only available in limited quantities. Second, organizations reflect

(in their forms) the conditions that they have experienced in their past. Such experiences either jeopardise or empower them when historical conditions, such as technology, change. Third, social phenomena, such as legitimation or proliferation of organizational forms, account for diffusion or competition intensification. Hannan and Freeman (1977, 1989) clearly displayed their Darwinian perspective by reformulating the Darwinian principles for social contexts. Moreover, they detached themselves from Lamarck's learning at the individual level by stating that, in the competitive process, "if there is a *rationality* in play, it is the rationality of natural selection (Hannan and Freeman 1977)" (Durand 2006, p. 63). However, concerning novelty in particular, they rejected the idea (which is crucial in Darwinism) of the relative advantage of the individual as the engine of evolution. In fact, variation in the individual is absent in the population ecology perspective. Instead, variation is conceived as changes in the environmental resources, political conditions and institutional movements (Durand 2006). The interest is, however, more on understanding the processes of convergence/divergence at the system/population level, rather than understanding the sources of novelty, which lie outside the main focus of this stream.

3.3 New Institutionalism (NI)

New institutionalism (NI) has been considered the dominant paradigm in organization studies (Gmür 2003). It shares with population ecology an interest on actual organizations, but with a focus on organizational fields (rather than populations), on norms (rather than resources) and on network relations among organizations (rather than on monolithic populations). Population ecologists have explained organizational heterogeneity starting from scarcity and selection operating in their resource environment, whereas neo-institutionalists have explained organizational homogeneity across resource environments as the result of norms and mandates such as laws, belief systems, cultural pressures and social comparison processes (Palmer et al. 2008).

In the 1970s, this theory developed within the movement of scholars (the Carnegie School being one of the main feeders of this position)

that shared the idea that organizations differ from firms and from their simple technical efficiency (Scott 2001). In their seminal contribution, Meyer and Scott (1983) distinguished the technical from the institutional fields to describe the technological state of the production function as well as the rules and regulations organizations observe to gain support and legitimacy. Meyer and Rowan's (1977) paper, which is considered the initiator of NI (Greenwood et al. 2008), claimed that organizations are the result of two main conditions: the institutional context and the network of organizations and exchange in which they are embedded. NI mainly developed the idea of institutional contexts, and while the investigation of the role of networks is still an important component of the explanation of such contexts, networks have also become the center of studies for a community of scholars at the crossroads of diverse perspectives in organization studies.

The field is the main and original level of analysis of NI (Wooten and Hoffman 2008), thus indicating the set of organizations that are not similar to one another (as in a population or industry), but which "interact with one another and are subject to the same regulative, normative, and cognitive institutional constraints" (Palmer et al. 2008, p. 742). Among the overwhelming majority of studies that have adopted a field-level perspective (Greenwood et al. 2008), proponents of NI have also offered studies at different levels of analysis, such as addressing the dynamics at the global level and at the lower level of organizational coalitions and individuals (Palmer et al. 2008; Aldrich and Ruef 2006). Furthermore, recent contributions (Powell and Colyvas 2008; Werner and Cornelissen 2014; Cornelissen and Werner 2014) examine NI at the micro-level of socially constructed cognition.

Overall, NI is more interested in persistence and convergence of organizational forms and behaviours than on novelty. Among the studies addressing change, four communities can be identified, which are relevant for understanding novelty. First, apart from the interesting study by Leblebici et al. (1991), which remained basically isolated, North American studies have assumed that novelty is exogenous (Greenwood et al. 2008). Novelty enters the NI picture as shocks or "jolts" (Meyer 1982) that storm institutionalised stable situations and cause the reconfiguration and realignment process that is most interesting for NI

(Greenwood et al. 2008; Aldrich and Ruef 2006). Such a model was revitalised with the inclusion of social movement theories in the late 1990s that studied how disadvantaged and repressed people use language to express emarginated ideas. It is through this reframing that they were also more accepted and widespread. These studies share with network studies that novelty enters the institutional process through peripheral actors that are less stable and more permeable to new ideas.

Second, studies addressing the relationship between organizations and the law have shown how the creative role of professionals, managers and legislators trigger change by interpreting ambiguous legislations, and provide novelty by implication. However, the community addressing the issue from this angle is unfortunately scant (Greenwood et al. 2008). Third, Scandinavian research focused on the process of emergence of voluntary regulations, such as standards, rankings and accreditations, as undersigned and spontaneous results of legitimation and institutionalization (Greenwood et al. 2008).

Finally, previous studies have taken novelty and the existence of institutions for granted, and they have focused on adoption and diffusion (Aldrich and Ruef 2006). A growing community is drawing attention towards the dynamics of creating institutions; that is, on the emergence of novelty deployed at various levels. Here, Leblebici et al. (1991) provided a parental perspective that seems particularly promising. More specifically, they conceived novelty as endogenously generated by peripheral actors and internal contestations (Greenwood et al. 2008, p. 19). At the individual level, studies on institutional entrepreneurship contribute to this stream. They also described individual institutional entrepreneurs who proactively act upon the field (Hardy and Maguire 2008, p. 198) and make novelty endogenously generated. Most studies on institutional entrepreneurship are developed around "actor-centric accounts" (Hardy and Maguire 2008, p. 199) of institutional entrepreneurs, and they illustrate the properties of individuals that were able to have an impact on the field. In such studies, novelty resides in the creator that, despite being part of the field, is also able to change the novelty. This apparent contradiction (Garud et al. 2007) was solved by considering that the field is a limited entity and that actors included in a field may also be part of other fields. As such, institutional

entrepreneurs are able to assume a different perspective from those in the field, without being superhuman. Moreover, studies adopting a "process-centric" perspective (Hardy and Maguire 2008, p. 199) have analysed the role of field conditions that create opportunities for institutional entrepreneurs. In this regard, two main conditions have been identified: (1) uncertainty, concerning the degree to which the future cannot be anticipated and solutions cannot be set; and (2) tensions and contradictions, which are always present in fields and provide opportunities for change. For example, the historical case of Cosimo de Medici, masterly analysed by Padgett and Ansell (1993), in addition to studies adopting a more traditional field-level perspective on capitalism and science (Padgett and Powell 2012), accounted for the emergence of new organizations or new markets.

Following Durand's (2006) approach, accurately categorising NI as Darwinian or Lamarckian is not easy, given the plethora of contributions that belong to this stream. As it is particularly true in this case, positions are not homogeneous, and it is only possible to provide a general discourse. NI focuses attention on selection and convergence mechanisms involving organizations and their environments, thus displaying a typically Darwinian perspective on evolution. In fact, the central phenomenon they address is the isomorphism of actors within a field. However, they explained it as the result of an institutional process rather than of an advantage in efficiency, as in biological evolution. Institutionalization reflects the acquisition of features through imitative processes based on legitimization, a perspective that is typically Lamarckian. Finally, the role of individuals and their intentionality have only been recently considered in studies on institutional entrepreneurship that appear to further introduce a Lamarckian perspective in NI.

3.4 Evolutionary Economics (EE)

Like PE, evolutionary economics (EE) builds on similar considerations on the scarcity of resources in the environment, compared to the population of firms. However, it develops its explanations by combining firm-level and industry-level perspectives (Durand 2006). Central

to such an explanation is the technological trajectory deployed at the system or industry level, meaning the technical and learning dynamics of technological evolution, where radical innovation sets a new technological trajectory and incremental innovation refines this trajectory (Rosenberg 1976; Nelson and Winter 1977; Dosi 1988; Dosi 1982).

Novelty, which refers to innovation in this stream, is represented by two main degrees of performance change: incremental and radical. Selection pressure on organizations varies according to the phase of the technological trajectory (e.g., at the beginning or when a dominant design has settled), and its impact will be diverse on organizations at different stages of innovation development. For example, when a new dominant design is set, selection on passive firms will be higher than on innovators. The opposite applies in the initial stage. EE, paired to this picture of selective evolution based on technology evolution, provides an explanation grounded in firm strategies. On their side, firms define (even within a path-dependent realm of actions) how much selective pressures will affect them. Nelson and Winter (1982) identified routines as the basic working elements of a firm. They also identified three types of routines: (1) operational routines, concerning firms and consolidated solutions; (2) generic routines, concerning incremental change by introducing improvements to operational routines; and (3) search routines, concerning new combinations of factors that provide radical innovation. The breakdown between these three types of routines, proposed in organization studies through the exploration and exploitation trade-off by Levinthal and March (1993), defines the organizational trajectory and its ability to become part of a technological trajectory by producing innovation (see the following organizational search literature as an extension).

3.5 Dynamic Capability (DC), and the Resource-Based View (RBV)

While EE elucidates the interaction between the industry and firm levels concerning evolution as technological change, it does not embrace the sources of competitive advantage (Foss and Eriksen 1995). As Montgomery (1995) claimed, the resource-based view (RBV) of

the firm and the dynamic capability (DC) streams of research fill this gap. The RBV maintains that firms' likelihood to survive and succeed depends on their idiosyncratic resource endowment that gives them the opportunity for rent appropriation (Amit and Schoemaker 1993). Such endowment is attachable by competitors, and the sustainability of a firm's privileged asset position is based on the control and management of strategic resources, including the acquisition of new resource bundles or the strengthening of the relatedness of resource portfolios. A firm's competitive advantage originates from a position of arbitrage (Makadok and Barney 2001) from which it can capture the value of some resources, while it is temporarily under-valued by the other players in the industry (Durand 2006). Indeed, the actual ability of the firm to uncover potential resources in an early phase is crucial to the survival of the firm (Makadok 1999).

Within this framework, DC stressed the role of the firm in defining and leading the technological trajectory in the industry, which is no longer seen as a natural path (Henderson and Clark 1990). Firms conduct their own evolution (Bonardi and Durand 2003) by "modifying the competitors' perception and displacing the locus of economic selection towards new capabilities and resources" (Durand 2006, p. 72). Competitive advantage not only resides in resources but also in "dynamic capabilities"; that is, the ability "to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997, p. 516).

Concerning novelty, it is possible to consider that, in EE, the RBV, and DC, the origins of novelty remain poorly explained. In fact, previous contributions have not satisfactorily addressed the origins of an organization's uniqueness (Foss and Knudsen 2003), while some, for example, Porter (1991), conceived novelty as deriving from firms' initial conditions and managerial choices. Overall, such studies have stimulated more questions than answers (Durand 2006, p. 73). In fact, it is difficult to distinguish between the initial conditions of a firm and the conditions it produced through its actions. Moreover, it is necessary to clarify what we understand as managerial choices. Reflecting both the engineering approach to organizations that was typical of the post-World War II economy (Palmer et al. 2008) and the full rationality

models of economic choice, it seems that this perspective is overarching its confidence that strategies are always deliberate and purposeful. In fact, the strategy literature typically assumes that, when this is not the case, management should correct the decision-making process. However, since the 1960s and more consistently, since the 1970s, scholars have indicated that organizational decisions are taken for social, power and time dynamics, rather than for accomplishing the goals that they deliberately pursue (March 1994). Such evidence did not spread into strategic management with equal power as it did in organization studies or as it would have in the management (Khurana 2010) and applied science fields (see, for example, how management was conceived in the opening article of *Management Science*: Smiddy and Naum 1954).

Finally, EE, in addition to the RBV and DC, combine different evolutionary traditions from biology in building their explanations of change (Durand 2006). In general, EE has broadly referred to Lamarck's ideas, and with reference to the role of habit, it is embedded in the concept of routine and imitation, in particular. Moreover, the RBV develops the advantage of variation at the firm level, which is typical of the Darwinian perspective.

3.6 Organizational Learning (OL)

In an evolutionary perspective, learning "occurs when experience systematically alters an agent's behaviour and/or its knowledge (Argote 2013; Miner and Anderson 1999)" (Miner et al. 2008, p. 152) in order "to alter their fit with their environment" (Aldrich and Ruef 2006, p. 47). The simplest evidence that strongly stimulated the research on learning concerns organizations displaying a decreasing rate in their costs or production time as output increases (Ingram; Argote 2013). Beyond this evidence, learning is typically observed in behavioural changes, but cognitive changes of mental models and beliefs are also implied (Argote 2013; Levinthal and March 1993; Miner and Mezias 1996). In addition, learning is complementary to novelty, and novelty is the reason for learning (Levinthal 2008). Learning also consists of the

inclusion of the experience stimulated by something new into organizational knowledge. The concept of learning does not underlie the link to success, since learning can produce both positive and negative outcomes. Furthermore, learning does not involve random change, but it concerns "patterned change over time" (Miner et al. 2008, p. 152).

It is possible to distinguish two streams of research in organizational learning (Glynn et al. 1994). The adaptive learning perspective, introduced in the books by March and Simon (1958) and Cyert and March (1963), assumes that organizations modify their behaviours according to the feedback from the environment; that is, they repeat successful behaviours and discard unsuccessful ones. Success and failure are assessed by comparing performance feedback and aspirations, and such data builds experience.

Although experience is the main source of learning, organizations also display severe limits in their learning abilities, which contain the expansion of knowledge and the variety of change that they can produce (e.g., March 1991; Levitt and March 1988; Levinthal and March 1993; Denrell and March 2001). Both ideas of learning as rational and non-rational have room in this perspective (Schulz 2002). On the one hand, learning concerns a strategy for the improvement of performance and adaptation. On the other hand, learning is ruled by automatic or semi-automatic dynamics that require no or limited rationality (Simon 1955).

The idea that experience is the main source of learning also means that, in this perspective, history is the main source of novelty. However, this does not imply that organizations' experience is only exogenous. Endogeneity occurs when what has been learned determines what will be experienced and learned in the future (Schulz 2002). Competency traps (Levitt and March 1988) are a typical example in which "favorable performance with an inferior procedure leads an organization to accumulate more experience with it, thus keeping experience with a superior procedure inadequate to make it rewarding to use" (Levitt and March 1988, p. 322). Conversely, prior learning can also broaden organizational learning abilities, for example, when they increase their absorptive capacity; that is, the ability of a firm to recognise and assimilate the value of new, external knowledge, and apply it to produce innovations

(Cohen and Levinthal 1990), or when rules are imposed to make new experiences (March et al. 2000). However, limits persist in the ability of an organization to endogenously set rules that avoid its own limited perspective. In fact, both learning and the search for novelty are functions of prior knowledge, and they are path dependent.

Another stream of research within organizational learning is the knowledge development perspective (Aldrich and Ruef 2006). This is conceptually and empirically close to the work on technological evolution and knowledge creation/development in the strategy literature (Tushman and Anderson 1986) that focuses on firms as learning organizations (i.e., producing learning and efficiency or innovation as an implication), rather than as the locus of organizational learning. This stream of research aims at designing novelty; that is, identifying the strategies and the organizational structure for generating beneficial results for firms. For example, significant emphasis is placed on the network structure.

Two prominent research streams find their ancestors within the organizational learning literature: (1) the group of studies focusing on organizational search (OS) and on March's (1991) seminal contribution on exploration and exploitation; and (2) the group of studies focusing on organizational routines (OR).

First, at the crossroads between organizational learning and evolutionary economics, the literature on OS provides an important perspective for understanding novelty that often assumes a strategic approach (e.g., Dosi and Marengo 2007; Katila 2002; Katila and Ahuja 2002; Levinthal 1997; Winter et al. 2007; Knudsen and Levinthal 2007; Levinthal and Warglien 1999; Siggelkow and Rivkin 2005; Gavetti and Levinthal 2000). OS shares with other streams the contributions offered by Cyert and March (1963), March and Simon (1958), Simon (1955) and Nelson and Winter (1982), builds on their idea of a search based on performance gaps and on the availability of slack resources (either automatic or deliberate), and adopts computer simulations as research method. Among other simulation models (Fioretti and Lomi 2011), since the contribution of Levithal (1997), Kauffman's "tunably rugged" NK fitness landscape has been widely adopted to study search routines and learning. In fact, the metaphor

of NK fitness models has been used as a theoretical device for representing and understanding decision problems (Levinthal 1997; Winter et al. 2007).

In NK models, the landscape represents solutions performance. A bounded rational agent is only able to perform a local search to move incrementally among the problem solutions. In this approach, one is easily trapped in local peaks and is unable to perform a distant search, since the perspective is limited by short sight. As Afuah and Tucci (2012) clarified, local and distant searches are often implicitly meant to represent March's (1991) exploitation and exploration, where exploitation refers to "refinement" and exploitation refers to "experimentation" and "discovery" (March 1991, p. 71). Hence, this literature provides a framework for novelty that allows one to trace the impact of novelty itself, measured in terms of cognitive distance, while considering the effort required to reach a point on the landscape. As such, local and distant searches are meant to potentially produce incremental novelty or breakthrough novelty, respectively.

Second, the original conception of learning has been refined and extended by the cornerstone contribution of Levitt and March (1988), which established a link between the organizational learning approach and the notion of routine. Routines, as discussed by Nelson and Winter (1982), were seen as elaborating on Cyert and March's (1963) concept of "specific operating procedures". In this regard, routines build the repository of organizational knowledge acquired through experience across personnel turnover and time; that is, they serve as organizational memory. While routines are a fundamental construct for both evolutionary economics and the strategy literature in the RBV and DC streams, the corpus of research is clustered around the perspective of Feldman and colleagues (Feldman 2000, 2003; Feldman and Pentland 2003, Pentland and Feldman 2005, 2007; Pentland et al. 2012) on OR. Their research stems from a proper interest on organizational functioning, rather than on a firm's success. They also move the level of analysis from the organization to the routine itself, where change takes place and is originated. In fact, they conceive routines as elements of endogenous variation and change; that is, "change […] is the result of engagement in the routine itself" (Feldman and Pentland 2003, p. 112).

3.7 Organizational Cognition (OC)

Research on organizational and managerial cognition focuses on the way individuals, groups and organizations notice, interpret and use information to make decisions and take certain actions (Lant 2002). The roots of a reflection on these issues date back, once again, to the seminal contributions of the Carnegie School and their open, information-processing view of firms (e.g., Simon 1947; March and Simon 1958; Cyert and March 1963). In contrast with the economic view maintaining that firms behave like rational actors, behaviourists started from the evidence that the way organizations decide and act in their environments "is contingent on the environmental interpretations of key participants who are responsible for monitoring, sensing, and interacting with external constituents and trends" (Porac et al. 2002, chapter 25). However, such interpretations are bounded, selective and often biased. For example, when information is too much for the processing capability of managers or sets of alternatives are not complete and derived from choices based on experience (March and Simon 1958; Simon 1947). Typically, individuals and organizations adopt heuristics to make decisions about the future (Porac and Thomas, 1990), or they bargain and achieve truces with coalitions in the present (March 1994).

More broadly, organizational cognition addresses how organizational members model reality and how such models are influenced by behaviours. While most research on competitive strategy still assumes (either implicitly or explicitly) that firms behave like rational actors (Rumelt et al. 1994), studies on managerial cognition provide an important contribution as to incorporate bounded rationality "into otherwise hyperrational theories" (Johnson and Hoopes 2003, p. 1057). Since this literature deals with the process of thinking and knowing (Lant 2002), research on cognition addresses both organizations and individuals. In other words, a focus on one cannot entirely exclude the other.

There are at least two ways in which cognition in organizations have been understood (Lant 2002). On the one hand, organizations are conceived as systems of information, and this view reflects the origins of the stream at Carnegie. On the other hand, they are considered as systems

of meaning. In the first line of thought, organizations are systems that code and process information. They are often modeled as computational systems that need to search for and elaborate on information, facing a twofold limitation of resource scarcity and bounded rationality (Porac et al. 2002). Novelty appears as a result of the incompleteness of decision sets of alternative consequences and states of the world or from their distorted perception or elaboration. When novelty is noticed, which typically occurs when consequences are negative or even catastrophic, it is included into the usual decision sets for the situation, with no further discussion of the origins of such poor decision representation.

In the second line of thought, Weick (1969, 1995) opened a perspective on organizations as creators of social meaning where individuals share a model of the world and the organization as well as their roles within them. Here, information is not ontologically self-consistent, but it is shaped and cognitively constructed in a collective and social way into shared sense. The relevant environment is that which is perceived through a sense-giving framework and thus "enacted" through the creative action of interpretation. Novelty appears as a discrepancy that requires a new process of sensemaking.

Recent studies have further developed these two lines of thought. Studies in behavioural management rely on experimental evidence (i.e., the controlled observations of human decisions) as relevant sources of managerial choices, and they inherit the Simonian perspective regarding decision makers. They also seem to "blame" humans (Augier and Kreiner 2000, p. 667) since they are missing the wits to understand a fully defined system (Loasby 1989). Moreover, they offer a set of correctives to redirect decisions towards rational behaviour. Such lists and guidelines highlight decision-making traps and suggest strategies to avoid them. Furthermore, they typically warn decision makers against following intuitive decision-making approaches that will most likely result in suboptimal decisions or distorted judgments (e.g., Bazerman and Chugh 2006; Hammond et al. 1998; Ariely 2010; Gino 2013). Here, there is little room for novelty (Augier and Kreiner 2000, p. 667), which (typically) are "errors" taking the form of biases and deviations, thus resulting in unexpected events or consequences.

An ecological perspective on the same limitations of rationality does not exclude "errors", but sees them as part of an evolutionary process through which individuals learn to recognise patterns and evolve towards decisional rules and heuristics that enable them to reach reasonable goals. Heuristics reveal the clever and parsimonious ways humans have evolved in order to act in complex environments (Frigotto et al. 2014). Here, novelty is the result of an evolutionary achievement, instead of the limitation of human cognition, time and experience. Novelty is therefore both endogenous and exogenous. In addition, it is related to a change in the environment that evolutionary heuristics are able to address, and to a restriction in the environment that decision makers must face.

A prominent and still emerging set of studies (building on Weick's cognitivism) has developed with the aim of capturing the micro-level institutional processes and mechanisms though a cognitive lens (Powell and Colyvas 2008; Cornelissen and Werner 2014). The following roles have been recognised with institutions (Weber and Glynn 2006): (1) Priming: institutions define the shared meaning and words that are used to make sense of certain situations; (2) Editing: institutions provide the locus for the social feedback that builds the recursive process of sensemaking; and (3) Triggering: institutions embed contradictions and ambiguities that influences discussions on sensemaking. Such institutionalised meanings that build the "taken-for-granted" models of interpretation of reality develop into institutional cognitive frames when actors—namely, institutional entrepreneurs—act strategically to shift to new frames or blend the existing frames with new ones (Werner and Cornelissen 2014).

A neglected, while relevant, theory of cognition is the pioneering contribution of Shackle (1979, 1972). While both Simon and Shackle started their work from their dissatisfaction with the neo-classical idea of decision makers being endowed with everything relevant to produce choices (Augier 2001; Augier and Kreiner 2000), they took two different approaches in building their perspectives. Simon adopted computational orientation, while Shackle adopted a philosophical viewpoint to criticise and rebuild decision making (Loasby 1989). In the latter approach, time is the main element in his decision-making models. In addition, time makes him consider the ontologically unknowable nature

of the future. In fact, the decision-making model adopted in neo-classical theory is only adequate if time does not exist (Augier and Kreiner 2000). Moreover, Shackle's decision maker is the creator of alternatives, conceived as imagined events, which may be experienced in the future.

Finally, choices, from his perspective, are not given, predetermined or predictable in their consequences. Conversely, they represent the origins of events that are continuously created as they are being experienced (Augier and Kreiner 2000). Choices are therefore made among imagined experiences whose indeterminacies are limited by the decision maker's knowledge, in terms of both what he/she considers to be true and what is deemed to be possible (Shackle 1979). He/she then assesses each experience in terms of how much its actual occurrence would be surprising. In other words, each experience is assessed in terms of how much it meets certain expectations. However, the likelihood, in terms of surprise, also includes an assessment of emotions that is exotic to most rationality models. Moreover, choices are made among alternative experiences, according to the highest satisfaction that the decision maker perceives in committing to a certain perspective of time. In this perspective, choices depend on an esthetic assessment of alternative experiences and on the commitment to realise them (Shackle 1979).

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Part II

A Framework for Novelty

4

Novelty Across Consequences and Control

4.1 Controlling Novelty?

This chapter begins with the consideration that organization studies display the twofold tendency to see novelty as both (1) controllable and (2) associated with success.

With respect to the first tendency, Chap. 2 showed that the issue of emergence and agency is central to evolutionary theories; however, it is even more central to organization studies, which focuses on subjects (at the individual, organization or system level) that can express intention and will. In those streams in which subjects' rationality is a central engine in environmental dynamics, meaning that subjects can decide to pursue one action according to the consequences they want to produce, novelty has attracted interest with the main purpose of taming it.

Building on the previous chapter, in the streams of literature in which novelty was modeled as endogenous, novelty has primarily been considered the result of rational will and intention, typically within a purposeful design. In addition, it has been entrusted to the actions and efforts of organizations (embodied by rational decision makers) in a framework in which the roles of firms' strategies and choices are emphasised. Studies on R&D programmes and innovation strategies reflect this position,

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which refers to a deterministic perspective on strategies and managerial actions (Stacey et al. 2000; De Rond and Thietart 2007) and can be partially related to the neoclassical roots of such a perspective. In fact, the neoclassical concept of decision making is deterministic in nature, since it theorises that the determinateness of a fixed preference function reveals the decision(s) that will be undertaken (Hodgson 1997, p. 407). In this context, the emerging character of the new, which includes non-controlled elements (often identified in terms of chance), has traditionally remained unexplored, and the potential scope of innovation has been significantly reduced to individual and organizational determination and determinateness. Moreover, the idea that emergence can be analysed and that what appears to be organizational disorder (Warglien and Masuch 1995) may, instead, reveal an emergent design that can only be seized from a post hoc perspective has largely been considered peripheral (if not heretic) to the core of formal organization theory. This stance reflects the general tendency of organization and management theory to stress the roles of order, control and predictability (Cunha et al. 2010).

Conversely, in the streams of literature in which novelty has been recognised as emergent, it has typically been described as exogenous. However, exceptions apply. When novelty has been recognised as both emergent and endogenously generated within the system being analysed, it has typically been referred to in terms of the sub-optimal unexpected results of an evolutionary process whose dynamics are impossible to isolate (Van de Ven et al. 2008, p. 4). The well-known cases concerning the settlement of the QWERTY keyboard as an inefficient standard (David 1985) and the propagation effects of negligence across the entire banking system (Bonabeau 2002) are prominent examples. Overall, as Cunha et al. (2015, p. 9) clearly stated: "The idea that chance events outside the organization's control and scope of action can have significant consequences is a threat to the certainty-oriented vision of the world espoused by dominant organizational theory." As a result, we know little about novelty and its emergence, even in its restricted form of innovation and its generative process (Van de Ven et al. 2008).

This situation is based on severe conceptual challenges that the mainstream literature has addressed, but not faced head on. As Stacey et al. (2000) claimed, the conventional stance of both scholars and managers

envisages that control is possible and that individuals are accountable for such control. However, in several important respects, though the future is not predictable, it is sometimes recognisable. As a result, individuals and students of their lives and behaviours, including organization scholars, have built and perpetrated a paradox based on the assumption that control is viable and that accountability is due, even though, in several significant respects, experiences do not depend on actions. While the paradox is difficult to sustain ("Managers are supposed to be in charge and yet they find it difficult to stay in control" [Stacey et al. 2000, p. 5]), it also provides a stable and safe area of action and relevance in which managers and scholars can find motivations to impact the future and explanations to understand the past. Bursting this bubble might appear to some to convey a loss of control and trust in individuals' abilities. It may also challenge the ontological and epistemological foundations of rationalist and deterministic paradigms, as well as the derived implications of engineering novelty (see Chap. 2).

This book takes the issue of control (i.e., of emergence and agency), as the first dimension along which a deeper understanding of novelty will be built.

4.2 Novelty: For Success or Toward Failure?

With reference to the second tendency of organization studies towards novelty, despite several notable exceptions, contributions to the understanding of novelty deriving from studies on innovation and creativity in strategy and entrepreneurship share a primary focus on the subset of the novelty phenomenon that can have positive effects and eventually lead to success (March 2010). This segment of possibility has been emphasised because of the benefits it can offer firms or society. Conversely, the possibility that novelty can have negative effects has typically been considered an inevitable deviance from the desired standard. In other words, the logic has been to support positive novelties and reduce (or possibly eliminate) negative novelties. This perspective has, therefore, ignored the fact that, most of the time, novelty is associated with negative consequences and that the generation of novelty with positive effects cannot

be preemptively distinguished from the generation of negative effects. In fact, the generative action is indifferent to the subsequent effect. In the literature, the preoccupation has been on the early selection of novelty, rather than on the properties of its generation across positive and negative impacts. This perspective has also contaminated the practice of industry research. As claimed by Munos (2009; Munos and Chin 2011), in the pharmaceutical industry, the effort to reduce the variance and increase the predictability of innovation (i.e., to select positive novelty in early stages of development) has decreased the number of new drugs brought to the market and created a generalised crisis regarding vivacity in the system.

From the opposite point of view, the literature on emergency management has addressed the negative effects of novelty, such as emergencies and disasters. The relevance of novelty in this context is increasing because, while most risks can be easily referred to standard cases, today's threats often concern novel emergencies that are so different from typical situations that scholars consider them to be "unthinkable", or pure novelty. Extremely harmful cases representing this category include the 9/11 terrorist attack and the mad cow disease crisis. This stream of literature suffers from the opposite bias displayed in the literature on innovation: that is, contributions are unable to draw correspondences and opposites when attempting to sketch unifying frameworks of understanding (Scott in Weick et al. 1999; Rerup and Levinthal 2014). The attitude towards novelty is also the opposite. Specifically, whereas studies on innovation support novelty (and try to design it), the literature on emergency management aims to avoid it.

Finally, while complementary, these perspectives are still somewhat different. This discrepancy was identified in emergency management as early as the seminal studies of Turner (1976) and Scott (in Weick et al. 1999), and it is still unresolved (Sutcliffe and Vogus 2014; Rerup and Levinthal 2014). Therefore, this book is built on the idea that these perspectives, when taken together, offer a richer understanding of novelty by combining the strategies adopted by each side to manage it. This book considers consequences to be the second dimension along which contributions can be organised and which can provide diverse but complementary approaches to novelty.

4.3 The Framework

The framework for this book builds on the idea of novelty as a unique phenomenon that can be addressed along the two dimensions listed below. Traditionally, these dimensions have partitioned, rather than specified, novelty in the literature. Here, however, they are used to identify types of novelty and to build an inclusive understanding of novelty.

1. *Consequences*: Novelty can have positive and negative consequences. In the first case, novelty is typically addressed in terms of innovation, invention, discovery and creativity. In the second case, novelty is addressed in terms of disasters, emergencies and hazards.
2. *Intention and control*: Novelty can be generated intentionally, through designed and controlled activities, or through evolutionary dynamics, which result from a set of actions/interactions that are not intentional, programmed or controlled.

By plotting these dimensions, it is possible to build a matrix in which the novelty types, which may be intended as extremes, pure cases or "ideal types" of the phenomenon, can be positioned (Weber 1978). These, like the other classifications that appear in this book, describe the conceptual types that do not necessarily appear as such in real life. In fact, they represent, in a unified construct, a "one-sided accentuation of one or more points of view" (Weber 1904; 1949, p. 90).

The aforementioned types of novelty represent the extremes of the novelty phenomenon in relation to both novelty's consequences and its intentions and control. In the case study method, extremes are considered because they make differences more apparent (Flyvbjerg 2004; Siggelkow 2007) and facilitate an understanding of the role of the variable on which they are built. This book uses extreme ideal types and the knowledge that has been produced around them in order to investigate what these types have in common (in terms of underlying structures), rather than highlighting their differences. In particular, this book builds on the idea that understanding novelty requires regaining a clear understanding of both design and emergence and positive and negative novelties.

At this point, it is appropriate to clarify that reality is populated by several cases that cannot be positioned in only one area without raising doubts concerning their pertinence to other areas. For example, innovations are often the result of both designed research and fortunate discovery. In general, designed and emergent ingredients are typically intertwined, to the point that they may appear as "meltdowns" in observed phenomena (Nelson and Winter 1982, p. 11), despite the fact that reflections on their existence have typically grown autonomously. With respect to the dimension of consequences, the classification of real-life cases is also difficult. The point of view through which novelty is observed is crucial for assessing whether it belongs to the realm of gains or the realm of losses. Moreover, there may be more than one consequence to consider, and the possible effects may act in different directions. To complicate things further, these two facets are often combined. Consider, as an example, when a technological innovation allows an organization to improve the value of its products (positive consequence for the consumer), which, in turn, reduces the value of previous technologies and the companies that dominated them (negative consequence for the previous technology leader).

There are four quarters that can be derived from the interaction of the two dimensions presented above (Table 4.1). However, this book will only consider three of them, since Quarter 1—that is, the pursuit of negative novelty (novelty that produces negative consequences to those who have designed it)—represents a situation that is unlikely or non-existent. In fact, while it is possible to imagine novelty which is designed by some to provide negative consequences to others e.g., new forms of terrorist attacks, this matrix assumes the perspective of the agent which *suffers the consequences* of novelty. To this actor, new forms of terrorist attacks are negative novelties that are emergent (while other actors have designed them).

Quarter 2 refers to emergent novelty with negative consequences. As stated earlier, instances in this type include new disasters, emergencies and hazards. While civil protections, emergency agencies and other emergency management organizations prepare to respond to typical and frequent hazards, there are always cases that fall outside of these categories; these are the novelties and anomalies. The 9/11 terrorist attack is an example of this type. Studies on this topic have been challenged by the non-foreseeability

Table 4.1 Novelty across consequences and control

Consequences/ Intention and control	Positive novelty	Negative novelty
Designed novelty	Instances: R&D pursued outcomes, new products, new markets, new strategies Focus: production of novelty Stand: Generative **4**	n.a. **1**
Emergent novelty	**3** Instances: serendipitous innovations and fortunate variations Focus: inclusion/absorption of novelty Stand: Catching	**2** Instances: disasters, emergencies and hazards Focus: detection and recognition of novelty Stand: Avoidance/Defense

of these types of events and by their threatening impact. In fact, their contributions are framed in terms of avoiding (or skipping) such novelties or, when this has not been possible, reducing their effect. The way in which this literature has responded to this challenge is by analysing the ability to detect and recognise novel emergencies that are about to occur, which is typical of resilient organizations in the field.

Quarters 3 and 4 refer, respectively, to emergent and designed positive novelties. Instances that represent Quarter 3 include serendipitous innovations and fortuitous fortunate variations. The literature focusing on this type attempts to find ways to include and absorb such novelties. Quarter 4 concerns such cases as planned or pursued innovations within R&D programs or new products, markets and strategies that are carefully scheduled and designed. Organizations are typically focused on structuring or supporting the generation of positively designed innovation.

This book will address these areas in order to build an inclusive perspective, rather than a selective and specialised perspective, on novelty. Through the comparison and analysis of common elements and issues, this book seeks to provide a deeper understanding of novelty in terms of common constituents and to lay a set of research tracks for its further investigation as a unique phenomenon.

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5

Black Novelties and the Early Recognition of Emergence

5.1 Overview

This chapter presents the contributions that the literature on organizational learning and cognition and emergency management can offer to the understanding of a unified perspective on novelty. In this literature, novelty is investigated in terms of disasters, emergencies and hazards; that is, in terms of novelty associated with effective or potentially negative consequences. In this context, since novelty concerns the threat to human life and resources, the main challenge is to mitigate or avoid its impact.

In this realm, novelty is typically unpredictable, and control over it takes the form of contention and anticipation. This realm, therefore, provides an ideal case for studying control in novelty generation because it offers a context through which to distinguish and separate the two fundamental dimensions that explain novelty, which are often confused or overlapped. These two dimensions are: (un)predictability, referring to the uncertainty concerning the timing of a manifestation; and (un) thinkability, referring to the impossibility of imagining a manifestation. Emergency management studies have helped to address uncertainty by supporting the development of the ability to respond to regular but

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unpredictable events. However, some recent major emergencies (e.g., the 9/11 terrorist attack) have posed significant challenges to the emergency management paradigm that have required different approaches and competencies. While we address the individual and organizational origins of the "unthinkable", we discuss the extent to which the unthinkable property of novelty requires new approaches and tools in emergency management. In Chap. 7, we will transfer these considerations to a more general concept of novelty.

This chapter is organized as follows. Following an introduction on the perspective of emergency management, which is necessary for understanding the orientation of the studies, we present the challenge posed by the so-called "new emergencies". Several labels have been shaped to address such emergencies, and diverse characteristics of novelty have been identified. We discuss their differences and their implications for learning and preparedness. Overall, this chapter is developed in terms of the cognitive and behavioural challenges concerning the recognition of and responses to new emergencies.

5.2 Resilience and the Perspective of Emergency Management

Emergency management arose from the necessity to deal with a disaster, which, according to the *Merriam Webster Online Dictionary*, is "something (such as a flood, tornado, fire, plane crash, etc.) that happens suddenly and causes much suffering or loss to many people". While the negative effect of disasters is the characteristic that motivates both the development of practices and scientific studies, another factor that further complicates the situation concerns the suddenness of such events. The Latin origin of the word *disaster* embeds these two meanings.[1] In addition, the word comes from *dis-astro*, which includes the term *astro*, meaning "star". In fact, the Romans talked about stars as the expression of fate, as in the English expression, "born under a lucky star". Meanwhile, the *dis*-prefix suggests the absence of or the opposite of favourable fate. Thus, disasters are negative novelties that have the characteristic of occurring unexpectedly.

Emergency management's initial mission was to effectively *respond*[2] and *recover* from great disasters, mainly calamities. Consider the fact that the Federal Emergency Management Agency (FEMA) in the United States was founded in 1979, and the Civil Protection Department in Italy was established in 1980 after the devastating earthquake that occurred in Irpinia (Southern Italy), where about 2900 people died and 280,000 people lost their homes. Before these agencies were founded, response and recovery were mostly improvised and relied on private solidarity and military operations. Subsequently, the phases of *preparation* and *mitigation*[3] were added to the wide range of activities of emergency management and emergency/safety organizations. Accordingly, FEMA's mission is "to support our citizens and first responders to ensure that, as a nation, we work together to build, sustain, and improve our capability to prepare for, protect against, respond to, recover from, and mitigate all *hazards*".[4] Figure. 5.1 shows the cycle of emergency management, including the four phases.

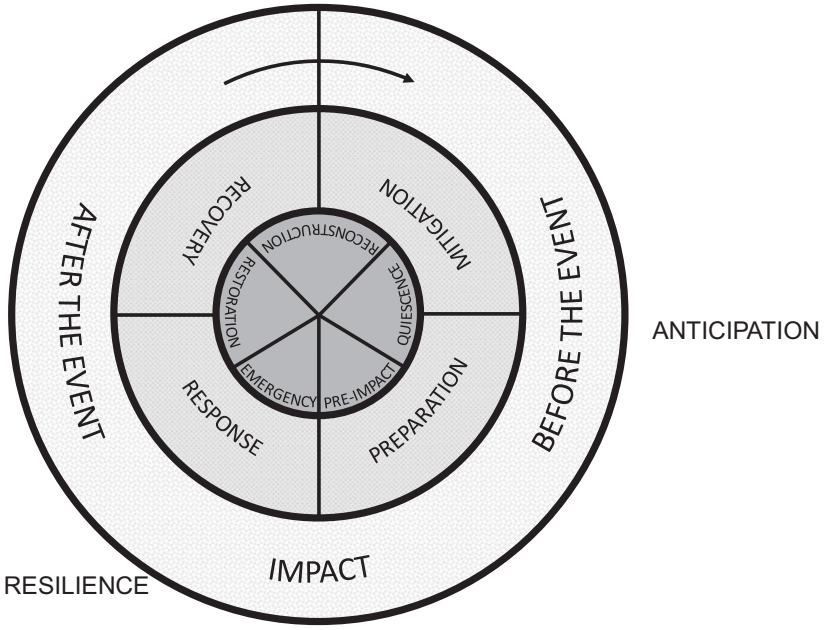


Fig. 5.1 The disaster management cycle and the positioning of anticipation and resilience

Emergency management organizations have accumulated knowledge and a team of professionals that, despite the peculiarities of each situation, can respond and contain the effects of disasters. Typically, both the knowledge and the expertise take the form of well-performed contingency plans that define each type of disaster, after which a pre-defined and familiar package of activities, tools and procedures are applied. This well-defined form of knowledge provides a solid basis for action, prevents paralysis in the face of disasters (Lagadec 2007), allows large diffusion and supports refinement by establishing clear objectives.

Moreover, as the response was becoming increasingly organized, attention was drawn to the possibility that threatening events are inevitable. Thus, efforts should be devoted to building *anticipation*; that is, the organizational capability "to predict and prevent potential dangers before damage is done" (Wildavsky 1988, p. 77, quoted in Bruijne et al. 2010). Both in building response and anticipation capabilities, emergency management has addressed "known threats and problems" and aimed at making organizations transform into efficient systems that are "resistant and robust to specific threats" (Bruijne et al. 2010, p. 21). However, what was already apparent to emergency organizations was that known threats were not the only cases that they had to learn to face on a regular basis.

Drawing from previous developments in engineering, biology and psychiatry, Wildavsky (1988) was one of the first researchers to propose the concept of *resilience* in the social sciences, as opposed to anticipation (Bruijne et al. 2010): "Resilience is the capacity of a social system (e.g., an organization, city or society) to proactively adapt to and recover from disturbances that are perceived within the system to fall outside the range of normal and expected disturbances" (Boin et al. 2010, p. 9) "after they have become manifest" (Wildavsky 1988, p. 77, quoted in Bruijne et al. 2010). In other words, resilience is the ability to deal with novelty occurring unexpectedly.

The concept of resilience was adopted in organization studies through the so-called high reliability theory. Scholars within this stream (LaPorte 1996; LaPorte and Consolini 1991; Roberts 1990; Bigley and Roberts 2001; Weick et al. 1999; Weick and Sutcliffe 2001) focused on a peculiar set of organizations; that is, the so-called high reliability

organizations (HROs), such as nuclear power plants, aircraft carriers, air traffic control systems, emergency rooms, and others, which could guarantee high levels of reliability and safety, despite dealing with complex and tightly coupled technologies (Perrow 1999). In other words, since the problem of unexpected emergencies could not be solved through "problem avoidance", organizations approached it through the idea of "high reliability" (Rochlin 1996; Weick et al. 1999).

Weick and Sutcliffe (2001) explained HROs' success as deriving from a combination of anticipation and resilience. More specifically, HROs can both implement stored responses to anticipated threats in an error-free manner and build ad hoc responses to unanticipated events. They also rely on (Bruijne et al. 2010) structural flexibility and organizational slack (Weick et al. 1999; Roberts 1990; Weick and Sutcliffe 2001), sensemaking (Weick 1993; Weick et al. 1999), a culture of reliability (Weick 1993), mindful attention during operations, also known as "heedful interaction" (Weick and Roberts 1993; Weick and Sutcliffe 2007; Levinthal and Rerup 2006; Rerup 2009) and improvisation (Weick 1993; Rerup 2001).

The implementation of this mix of anticipation and resilience requires a balance between contrasting goals such as efficiency and reliability (Bruijne et al. 2010) that is extremely difficult to modulate and to maintain over time. Recently, the level of difficulty has dramatically increased, since the emergencies have greatly differed from previous ones (Lagadec 2007). In particular, each time HROs fail to effectively respond to disasters, the balance that they have implemented is questioned, which, in turn changes the response from a standard solution to improvisation.

5.3 Novelty from Regular to Unexemplified Events

Emergency organizations have been designed to face hazards, whose threatening power varies according to two dimensions: predictability and potential disruption. Predictability does not imply the ability to "predict when the event will take place" (Westrum 2006, p. 55), but it

includes the identification of the threat among possible ones. Potential disruption concerns an evaluation of the threat's impact on the system as well as its relevance; that is, an event with high disruption potential threatens to disrupt the system. Building on Westrum (2006), three classes of situations can be identified along predictability and potential disruption: (1) regular threats; (2) irregular threats; and (3) unexampled events. Novelty is present in all the three classes but with a different meaning.

Regular events are events that occur according to a typical frequency[5] and that reflect a typical distribution. In order to face such events, emergency organizations have developed standard responses.[6] For example, an intervention to extinguish a fire without causing complications for the firefighters belongs to this category. Overall, regular events are related to a group of actors who have the knowledge to deal with them, illustrating that regularity is a relative attribute. However, regular events are not unforeseen or abnormal events. Instead, they follow a pattern that is broadly predictable. Here, one specification is necessary: defining events as regular does not mean that they are all the same. Regular events display variety, and none are perfectly identical; however, the novelty is limited to what can be interpreted as variations. This consideration highlights that novelty is a continuous variable rather than a dichotomous one.

Irregular events are events that rarely occur or that display certain peculiarities that require important variations in response. According to Westrum (2006), an example of an irregular event was the 2004 suicide bombing of an American mess tent in Iraq that resulted in 22 deaths. In this case, the support hospital had to self-organize to deal with a wide array of cases that it was not designed to handle under such threatening conditions. Irregular events, therefore, imply a more substantive type of novelty that requires important changes in response or the elaboration of a new response. They consist of new events that are not included in the list of standard cases, but appear as cases that might require great or even unreachable modifications to address but are not difficult to interpret or conceptualise into a set of similar cases.

Unexampled events are events that are not deemed possible before they occur. The classic example is the 9/11 terrorist attack to the World

Trade Center in New York, which has characterised the years since 2001 (Westrum 2006; Frigotto and Narduzzo 2016). These events ask people to confront not only the difficulty of developing new responses but also to work on new conceptualisations and new categories that might include them. Here, novelty is at its extreme level and concerns not only the realm of possible responses but also the realm of possible conceptualisations. Note that such events tend to seem more predictable in retrospect, and their consistency tends to fade as time passes (Cunha et al. 2006). This is at least partially due to the fact that people tend to overestimate the predictability of an event after it has occurred. This is the so-called hindsight bias (Fischhoff 1975; Harrison and March, 1984), according to which "people have the impression that the decision makers could have known and, therefore, should have known what would happen" (Goitein 1984, p. 411)—and as a result, could and should be ready to face such a scenario. This tendency makes it even more difficult to define the category of unexampled events because, while these events may, at first, be identified as unexemplified events, as time passes, they are repositioned as irregular events.

5.4 Positioning Diverse Labels and Research on Recent Emergencies

Between 1950 and 1960, emergency management grew with the aim of building a knowledge infrastructure and technical expertise to manage regular events and face irregular events. However, many of the recent emergencies hardly fall into the category of regular or irregular events, such as the contamination of the bovine spongiform encephalopathy ("Mad Cow Disease") or the 2012 blackout in India, which involved 600 million people. Such emergencies reflect the peculiarities of the modern world, where social, political and economic sources of emergency are intertwined and linked to environmental emergencies.

Research on these recent events has been carried out under diverse labels, each of which has addressed peculiar traits of recent emergencies. Table 5.1 presents a synthesis of the diverse labels and of the related

Table 5.1 Map of tentative conceptualizations of the novelty appearing in recent emergencies

Labels adopted in the literature		Rare events	Extreme events	Predictable surprises	Black swans	The unexpected	The unthinkable
	References	Lampel et al. (2009); Rerup (2009)	Comfort et al. (2010)	Bazerman and Watkins (2004)	Taleb (2007)	Weick (1993); Weick and Sutcliffe (2001)	Quarantelli 1989; Boin and 't Hart 2006; Lagadec 2007
	Contributions focusing on	Frequency	Impact	Availability of information, distorted attention	Rarity, impact, unpredict-ability	Expectations (state of the art of knowledge; individual and social cognition)	Loss of meaning; ad hoc response
Westrum (2006) categories of events	Regular						
	Irregular	X	X	X	X	X	
	Unexemplified				X	X	X "new emergencies"

focus. The lower part of Table 5.1 links the labels with the categories introduced by Westrum (2006).

First, the literature has addressed *rare events*, based on the frequency of their manifestations (Lampel et al. 2009; Rerup 2009). Second, focusing on the extraordinary impact rare events can produce, the literature talked about *extreme events* (Comfort et al. 2010). Such discourse, raised within the literature on organizational learning and cognition, has stressed two aspects: (1) the difficulty of including outliers in predictions; and (2) the typical tendency of organizations to focus on normal cases and to forget rare ones.

Third, recent emergencies have also been referred to as *predictable surprises* (Bazerman and Watkins 2004), stressing the fact that there is available information that allows individuals to foresee such events. This literature has highlighted that there are political issues concerning the way responsibility and accountability is attributed to decision makers, which also impacts the decisions being made and the information being considered. As a matter of fact, addressing new emergencies require significant investments, which would only pay off if they actually occur. Such uncertainty implies that recent emergencies are not generally the top priorities of politicians. Such investments can be interpreted as a waste of resources or over-prevention. Moreover, recent emergencies are typically unforeseeable, which makes accountability limited or at least a debatable issue.

Fourth, in 2007, Nassim Taleb proposed the image of the *black swan* to describe an event that, despite its major impact, appears as a negligible variation from normal expectations. The context in which he discussed this instance of novelty is not mainly that of disasters (although he does refer to them). Within the financial markets, such events are the source of large gains by arbitrageurs. However, in disaster prevention, such events cause significant losses. The *black swan* theory is, in fact, a rebuttal of the normal distribution, as the foundation and focus of contemporary sciences. In addition to the *rare events* or the *predictable surprises* perspective, the *black swan* perspective stresses that the discovery of the existence of a *black swan* (event) provides a radical change in the consideration and predictability of its manifestation. Building on the metaphorical search for the *black swan* in the philosophy of science from Juvenale to Popper, it symbolises "the impossible" before it appears, since nothing can

convincingly point to its possibility. In other words, it is not imagined or deemed possible and thus, it is not searched or predictable. When its occurrence is recorded, however, people add it to the population of possible events. They also build explanations for its occurrence after the fact, and sometimes they also highlight the predictability of the event, claiming that information might have been available. While Taleb developed his argument based on narratives of historical events, the experimental literature has proved the existence of such change in attitude though laboratory research (Fischhoff 1975). In sum, the *black swan* is not just rare and extremely impactful, but it is also predictable in retrospect only. Thus, it appears as a surprise to the observer.

Fifth, the surprising nature of recent emergencies has originally been raised by Weick and Sutcliffe (2001) in terms of *unexpected events*. There are several ways in which an event can defy expectations. Frigotto and Narduzzo (2012) refined the categorization advanced by Weick and Sutcliffe (2001), by considering that the event can be unexpected in terms of content, timing, consequences, sequence of propagation, interactions involved or that it can concern more than one of these facets. Table 5.2 provides several examples of unexpected events from recent emergencies. Expectations reflect three aspects of an organization in particular: (1) the state of knowledge; (2) the individual cognition, including biases and limitations of its members; and (3) social cognition, referring to shared meaning and interpretation. Weick and Sutcliffe (2001) stressed that expectations largely reflect the social cognition of organizational members, because it builds the shared system through which organizational members interpret their present and their future and access solutions. As an example, in Weick's well-known analysis of the Mann Gulch disaster (1993), he compared the behaviour of the crew of expert firefighters that were killed by fire with the behaviour of the one who was able to enact a solution that saved him. Such a difference was not explained by the lack of knowledge of the misfortunate crew, but by the disintegration of the shared system of meaning and interpretation that allows to access viable solutions. In contributions referring to the unexpected, the focus is therefore on how to build such shared meaning and interpretation so that adequate solutions can be found.

Finally, some scholars have considered recent emergencies as revealing the need for a separate category; that is, the category of *new emergencies*

Table 5.2 Dimensions of unexpected events

Dimensions	Explanation	Examples
Content	The event consists of something unknown given available knowledge and experience	Asbestos was largely used in construction for several decades, after which evidence of its toxicity was scientifically provided, and its use was forbidden.
Timing	The manifestation of the event is not expected in that moment (the event has an early or late manifestation)	While avalanches and landslides are typical of Winter and Spring, there were collapses from the Top One Mountain in 2007 and the Euringer Mountain in 2011 in Summer in Italy.
Consequences	The consequences of the event are exceptional on some of the following aspects: -*intensity or magnitude*, -*duration*, -*propagation or extension*, -*sign of impact*	-Exceptionally intense events – e.g. 2013 snow storms in Italy; the Indian blackout on July 31, 2012: 600 million people in the dark -Exceptionally long events – e.g. heat waves with 15,000 deaths in France in 2003; -Disperse effects of broad propagation processes – e.g. the Icelandic volcano fumes diffused all over Europe; -Opposite sign than expected – e.g. impact of 2014 low Summer temperatures on tourism economics of Alpine regional areas: rather than a producing a loss, there was an increase in entertainment consumption such as museums.
Interaction	The event has an impact in connected realms	After the 2011 earthquake in Japan, a nuclear disaster took place.

(Quarantelli 1989; Boin and Paul 't Hart 2006; Lagadec 2007). In this regard, they provided at least two reasons. Firstly, such emergencies substantially deviate from standard crises. In contrast to the more traditional emergencies, the main feature of new emergencies is that their appearance, evolution, impact and consequences are "incredible" and "inconceivable" before they actually occur. For these peculiarities, they describe them as "*the unthinkable*" (Lagadec 2007). These are events for which there are no expectations, considerations or prior knowledge about their possible existence. They belong to an open set of cases, whose population gradually takes shape after becoming reality. In addition, what is challenging about new emergencies is that, once they have manifested, they also lose their peculiarity of being "unthinkable", which is the factor that made them so difficult to grasp and face in the first place. Thus, new emergencies are emergent and uncontrolled as

"unthinkable" and "inconceivable". Furthermore, they typically become known only after they have occurred, and in some cases, they require some time and reflection to actually be understood. In the face of such events, a loss of meaning typically takes place (Cunha et al. 2006): "People must step back from the situation at hand, revisit their assumptions, reframe the situation […] and engage in some type of higher-order evaluation, such as double-loop learning (Argyris and Schon 1974)" (Rudolph and Repenning 2002).

Secondly, the peculiarity of new emergencies is something that the literature on emergency management has, by far, been unable to frame (Quarantelli 1989; Boin and 't Hart 2006; Lagadec 2007). Such inability has been witnessed by the failures experienced when addressing these emergencies and attempting to learn from them. In fact, safety management organizations are built on a concept of preparedness, as theorised in the literature on emergency management, which builds on improving responses to a closed list of emergencies. The latter are known and predictable on a probabilistic basis. Given the emergent and peculiar nature of new emergencies, such conceptualisation is inadequate and such a response system is inapplicable. Moreover, in the case of new emergencies, critical skills for safety organizations cannot be limited to the ability to respond rapidly and efficiently to a closed set of alarms that are gradually updated after "the *last* new emergency" has occurred. Conversely, critical skills must be extended to the ability to recognise "the *next* new emergency"; that is, to read and understand the "unthinkable" novelty at the very moment in which it becomes reality or before it actually starts to appear. However, this ability to perceive new emergencies and their novelties requires an exercise of innovative thinking that goes well beyond the marginal improvement achieved by increasing the range of responses to listed and well-identified contingencies (Quarantelli et al. 2006, p. 36).

5.5 The "Unthinkable" and Its Challenges

All of the aforementioned streams of research share the consideration that both organizations and the literature in emergency management display a fundamental difficulty in dealing with and understanding

novelty, especially taking the form of the unthinkable as in "new emergencies". The challenge that new emergencies pose can be organized into four categories: (1) organizational cognition; (2) organizational response; (3) the integration of cognition and response; and (4) learning.

The first challenge to organizational cognition concerns the difficulty of anticipating that new events are coming, or when this is not possible, promptly understanding that such events are taking place. This book will refer to this ability as the ability to recognise new emergencies.

The second challenge to organizational response concerns the difficulty of dealing with events that do differ from known cases and are not understood when they occur. In such situations, it is unclear whether a response from the repertoire of established ones may provide a solution to the situation or if an ad hoc response should be built. These challenges are further exacerbated by the fact that, in new emergencies, scenarios often evolve with exponential rapidity and require organizations to work under tremendous pressure.

The third challenge is implied in the previous two categories. It concerns how cognition and response are integrated into an organizational system, and how such a system can deal with both new and known emergency situations. The integration of these two functions in two diverse situations poses a problem that is difficult to solve and requires a tempering of both a time shortage and a results-oriented pressure.

Finally, the fourth challenge refers to learning. The real challenge of learning from new emergencies concerns how to learn from them so that organizations are more prepared to deal with other events in the future.

5.6 Recognition

The ability to recognise has been described as the ability to classify or categorise the situation against what is known (Hermann 1972; Billings et al. 1980; Cowan 1986). When knowledge has reached the level of being developed into categories, recognition concerns the judgement about the affinity of the instances against available categories.

Despite that this can be achieved in a pseudo-automatic manner, when it involves typical situations and established routines for their classification (Becker 2004), they always involve judgement and decision making. In addition, when situations are non-typical, judgement and decision making become critical.

Typically, in the face of a new emergency, two situations can occur, both of which hinder their correct recognition. In the first situation, the new emergency is classified as belonging to a known type, while neglecting clues that are categorised as negligible variations. In the second situation, the new emergency is not even perceived (e.g., since it is inconceivable). In other words, the mistakes that can be committed are twofold. First, exchanging what is occurring with something you know or appears like something you know, and second, not noticing that something abnormal is occurring until it produces obvious damage. The oxymoron "recognise a new situation" expresses the complexity and contradictory nature of this problem.

Research on disasters (Turner 1976), organizational crises (Sheaffer et al. 1998) and organizational errors (Ramanujam 2003) have addressed such difficulties in terms of the inability to seize and respond to so-called incubators (Turner 1976), precursors (Tamuz 2004), clues or weak signals (Haeckel 2004; Rerup 2009), and abnormal signs (Weick et al. 1999) that reveal future threats (Ansoff 1975; Vaughan 1996; Weick and Sutcliffe 2007). This book defines capacity recognition as the ability to focus attention on the new aspects, which is the ability to notice, encode, and discuss the repertoire of available alternative categories to make sense of the world (e.g., emergency/non-emergency), and the available alternative actions (e.g., routines, projects, programmes and procedures).

In the tradition of the Carnegie School,[7] the missing recognition of new emergencies can be understood through an analysis of the following three aspects: (1) the cognitive limitations of decision makers; (2) the social and organizational nature of decisions; and (3) the ill-structured nature of decision-making contexts. The first has typically been expressed in terms of human deviations displayed in individual perception and judgement, with respect to the neo-classical decision-making model (Frigotto et al. 2014). The second concerns the organizational

and social determinants that affect recognition (i.e., procedures and rules that occur in the context of the division of labour), the culture in which such activity occurs (Ocasio 1997), and the coalition interests that are embedded in the prioritisation of certain decisions towards some events. The third highlights that new emergencies appear in a context that is not "well structured", meaning that relevant components are not given and well-defined into alternatives, consequences and preferences. Conversely, alternatives are blurred, causal relationships linking various events are not apparent, and the chain of consequences is highly indefinite. According to decision theory, these situations have been identified as ill-structured problems (Simon 1973; Hayes and Simon 1974).

5.6.1 Individual Recognition

There are several obstacles to the recognition of new emergencies that pertain to individual cognition. Due to these limitations, human decision makers are unable to perceive/judge the situation correctly and address new emergencies accordingly. Such obstacles of individual cognition are broadly comprehended under the umbrella concept of bounded rationality, as raised by Herbert Simon and the Carnegie School, and supported by the growing set of experimental evidence produced in the laboratory. The following will discuss the six main sources of constraint.

The first and simplest limitations of rationality concern computability and attention as scarce and constrained resources in human cognition (Simon 1955). High incoming information workflows typically provide the saturation of attention (March and Simon 1958; Cyert and March 1963; Ocasio 1997; Argote and Greve 2007) and the fallibility in judging priorities. The pioneering contribution of Turner (Turner 1976, Turner 1978, first edition; Turner and Pidgeon 1997, second edition) pointed out that "people are inhibited from communicating a problem […] because their attention is fully occupied in dealing with problems more clearly defined" (Turner and Pidgeon 1997, p. 52). In other words, attention is "selectively saturated" by cases that are more

clearly understood. Moreover, human information processing requires a certain amount of time, which cannot be reduced without possible errors. As Rudolph and Repenning (2002) indicated, the flow of information and the quantity of tasks to be processed have an impact on emergency management. Furthermore, when new situations are concerned, the required time increases and time constraints imposed by the situation have a significant impact on the successful assessment of certain cases (Weick 1990, 1993; Weick and Roberts 1993).

Second, decision makers suffer limitations in correctly understanding probability distributions (Hertwig et al. 2004). In a sense, their perception is not neutral in several ways. Individuals typically underestimate low probabilities; that is, rare events (Hertwig et al. 2004). They also neglect that they may be occurring and they tend to focus on the large majority of events that occurs more frequently. Moreover, in HROs, the misperception of probabilities also reflects that people naturally show some "reluctance to fear the worst outcome" (Turner and Pidgeon 1997, p. 88), which makes them automatically disregard information revealing such a result. Frigotto and Zamarian (2015) showed that Italian Air Force crews flying high-risk combat missions display such reluctance by removing the worst negative events from the set of possible events. The direct investigation of this point clarified that such forgetfulness allowed them to feel "safe" instead of petrified. From the cognitive perspective, such "purified" beliefs play the defender role. The denial of rare, worst-case events may also take the form of an under-valuation of the source of information, which is typical when the informant is not a member of the organization (Turner and Pidgeon 1997). Starbuck and Milliken (1988) revealed that the sequence of experienced events impacts the perception of probabilities. They also showed that repeated successes in NASA's Challenger program (up to 1986) produced a lower perception of possible failure, which made the tragic outcome even more shocking to those involved.

Third, human memory does not only impact the perception of frequency but it also impacts relevance. Recent events are considered more important and impactful than older ones, even if they displayed larger consequences (March 1994). In emergency management, this bias is

well reflected in political agendas, which typically contemplate interventions on safety, especially after significant emergency situations have occurred.

Fourth, decision makers tend to overlook anomalies or variations from the typical cases. This reveals that they are victims of competence traps (Levitt and March 1988). In fact, they tend to stress what is similar to standard cases, rather than understanding what is different and new. In other words, they tend to simplify the interpretation of the world (Turner 1976), which allows them to activate the standard answer and proceed to the next task. This strategy is based on the implicit assumption that once a crisis has been identified, it can be managed and controlled, since there is an effective package of activities, instruments and procedures (Lagadec 2007, p. 496). However, in this regard, anomalies tend to accumulate and unintended consequences are taken into account only when they can hardly be contained (Weick et al. 1999).

Fifth, individuals show a limited ability to imagine what they have not previously experienced (Shackle 1972). As such, the exploration of alternatives is endogenously constrained by imagination. The prospect of esthetic rationality of Shackle adds to this picture that, not only the exploration of reality typically occurs within the domains of knowledge that belong to the repertoire of the individual (Cohen and Levinthal 1990, 1994; Levinthal and March 1993; Shane 2000; March 2006), but also that the imagination undergoes this limit. In fact, the elicitation of "alternative imaginary"; that is, imagined experiences, is constrained by experience. In this perspective, the practice of using focus groups of experts to identify future risks (Ricci et al. 2003; Foster et al. 2000) represents only a partial solution to the problem.

Sixth, recent studies have considered the impact of emotions on decision making. In particular, in emergency management, both the high stakes (i.e., human lives, capital and natural resources) and the suddenness (i.e., surprise and disorientation, see Pina et al. 2006) imply that emotions play a significant role. In their analysis of one of the most emblematic new emergencies (i.e., the 9/11 terrorist attack), Frigotto and Narduzzo (2012) analysed how emotions impacted the operators of the 911 emergency response units.

5.6.2 Social and Organizational Recognition

A fundamental assumption of the study of decision making, from the perspective of the Carnegie School, is that human cognition is not reducible to individual cognition, since it occurs in organized social contexts (Simon 1947; March and Olsen 1976). Latour (1987), Lave (1988), and Hutchins (1995) showed that the cognitive ability of individuals unfolds through (and is shaped by) practices, rules, procedures, resources and technologies, which reflect both the culture and structure of social organizations (Hutchins 1995; Ocasio 1997). The following will focus on the two main sources that make cognition a social issue.

First, organizations are, by nature, the locus of the division of labour, and this implies that cognition is also socially defined. In organizations, the ability to recognise environmental signals is distributed as knowledge (Hayek 1937). Typically, different actors (i.e., individuals or parts of organizations) collect information, retain, and transmit fragments of them, which are used by other actors to make decisions. This means that missed recognition can occur under three situations: (1) the various actors do not have a general understanding of the situation and they are hardly able to distinguish the information from noise when a general overview of the specific case is required; (2) the problems of information transmission and communication become relevant, ranging from trivial errors in the transmission—for example, when information is sent to the wrong recipient or the content is distorted, to more complex cases concerning the nature of information that is transmitted; that is, when information is ambiguous; and (3) the architecture of communication includes a fundamental role and is related to the distribution of tasks and the control of interdependencies within the division of labour. The seminal contribution of (Turner and Pidgeon 1997) pointed out that organizations fail to recognise novel emergencies since several actors collect information and share fragments of such information, while decisions are typically made at the central level.

Second, organizational culture defines what is considered to be relevant and what should draw attention. In fact, formal rules and procedures as well as informal norms and practices define what is socially

accepted, including the possibility of focusing on problems that were not foreseen or expected. Turner and Pidgeon (1997) reported on organizational tolerance for violations in disaster management, especially when procedures were considered obsolete. Conversely, in the Tenerife air disaster studied by Weick (1990) and the Challenger disaster analysed by Vaughan (Vaughan 1990, 1996), cultural aspects played a primary role in triggering/supporting the phenomenon of groupthink (Janis 1982). When the latter occurs, those who possess vital information generally do not raise problems, ask questions and intervene (Bouquet and Birkinshaw 2008; Rerup 2009). Moreover, regarding the 9/11 terrorist attack, Bazerman and Watkins (2004) related the organizational failure of reacting properly to various leaders' inability of promptly bringing available information to light, thus revealing cultural rigidity.

5.6.3 The "Unthinkable" as an Ill-Structured Problem

The limitations deriving from individual cognitive biases and deviations as well as the social context are exacerbated by the ill-structured nature of problems that novelty as in new emergencies poses. Ill-structured problems are those in which alternatives, states of the world, and consequences are not given: solutions cannot be found by adopting an algorithm because explanatory dimensions have not been identified (Simon 1973; Hayes and Simon 1974). Solving such problems does not only concern the selection of an alternative but it also implies the structuration of the problem so that alternatives can be identified, scenarios can be imagined and assessed, and consequences can be predicted. Such structuration provides a problem representation (Newell and Simon 1972), and it is the result of creative effort (Newell et al. 1958). Moreover, it includes the merit of providing a context that heals the indeterminacy of the unknown where decisions are made. Conversely, it is also extremely risky, since it is frequently built on plausibility rather than validity (typically defined against experience) and on internal coherence rather than external coherence (Frigotto and Rossi 2015).

New emergencies are typically characterised by ambiguity or incompleteness of information, and by the lack of knowledge to interpret such information. Moreover, alternatives are blurred, causal relationships linking various events are not apparent, and the chain of consequences is highly indefinite, so that the impact of a particular decision is largely unforeseeable. The analysis by Frigotto et al. (2006) of the 9/11 terrorist attack showed that the clarification of what was actually occurring took place several hours after the attack. When decision makers deal with ill-structured problems, problem representations are continuously defined as tentative points situated in an indefinite space (Hayes and Simon 1974; Ungson et al. 1981). They also require the decision maker to set assumptions and elaborate theories that offer a structure to the problem, which, in turn, enables decision making. This activity is as difficult as it is disputable. In fact, in the realm of emergency management, new emergencies are often the domain in which it is easier to argue that mistakes and errors have been made. Moreover, given the non-forgiving, high-stakes typical nature of such emergencies, blame is frequently and strongly placed on certain individuals and organizations.

Ex-post rationalizations reflect the previously mentioned hindsight bias (see p. 99 this Chap.) and tend to forget the indeterminacy that decision makers experience before the new emergency occurs. In fact, after a new emergency occurs, they are able to understand events in a way that was not possible to ex-ante decision makers. In addition, they benefit from the knowledge that has become available after the fact, but they forget about this difference and tend to consider that the decision was relatively easy to make. Moreover, they judge choices accordingly; that is, they are much more severe towards perceptions/actions that proved to be incorrect. Misinterpretations of ambiguities and tentative problem representations of the indefinite are considered mistakes, and decision makers are generally blamed for them.

It is always dutiful to exclude incompetence from the picture, and this is why safety managers often head to court. However, it is also difficult to thoughtfully consider the differences between before-the-fact and after-the-fact knowledge. Several investigations on new emergencies have focused on the adequate circulation and consideration of information, as if information availability is the sufficient condition for good

decision making, whereas decision makers' recklessness/ineptitude is the explanation for bad decisions. However, if the difference between before-the-fact and after-the-fact knowledge is neglected, then information is easily considered unambiguous, environmental signals are considered as "waiting to be picked up" (Seidl 2004, p. 156; Maguire and Hardy 2013), and responsibility falls on those who do not "pick them up". Conversely, if we consider the difference between before-the-fact and after-the-fact knowledge in a situation, then one should take into account the following two aspects: (1) knowledge concerning emergencies is provisory and highly immature and there are still several events that are unknown that pose ill-structured problems when they occur; and (2) signals "are not primitive events—buildings are generated by people who try to understand the situations" (Klein et al. 2005, p. 17); that is, they are socially constructed interpretations of the state of knowledge and the state of the world, which are embedded into decision premises (Simon 1991) and problem representations (Newell and Simon 1972). These considerations provide a perspective on new emergencies in which the main issue concerns what decision premises and problem representations are available among emergency management agencies, the population, the courts, politics, and emergency management scholars, and how this impacts the recognition of new emergencies.

5.7 Response

Response is a crucial activity for emergency organizations. The contest of emergencies is extremely challenging, since it implies high risk and high stakes, and typically, short response times. For these peculiarities, gradual adaptive response through trial and error is not a viable option since, in emergencies, "the first error may be the last trial" (Rochlin 1999, p. 1552, cited in Bruijne et al. 2010), and there may be no time to receive and interpret feedback.

Response has been conceived along two opposite systems: planning and improvisation. As Miner et al. (2001) clarified, in any given moment, organizational action can either rely on a previously defined

design (i.e., execute a prior plan or pre-existing routines in their usual patterns) or define a new design (i.e., plan a new activity or improvise).

5.7.1 Planning

A set of standard responses has been identified with typical emergency situations. In this regard, contingency plans are a typical tool of risk management, which define, for each eventuality, the associated sequence of actions to be undertaken. In contingency plans, procedures, rules and workflows as well as responsibilities of command and control are established. Such standardization of operations allows significant diffusion of successful response practices such that diverse emergency organizations in different countries are currently endowed with sufficient and homogenous responses to the most frequent emergency situations. Moreover, such contingency plans have been used to clarify the meaning of accountability and responsibility in emergency organizations. As it is increasingly the case that emergency organizations are blamed for their interventions, when some failure or great damage has been experienced, contingency plans have become a defense tool in courts. The assumption is that contingencies define what can be done in emergency situations, and that once contingency plans have been properly implemented, any other occurrence belongs to the realm of chance that cannot be completely avoided. In fact, emergency organizations own numerous books in which they have specified their contingency plans and devote part of their time in practicing such plans.

Emergency exercises are used to rehearse anticipated emergency scenarios and to fine-tune procedures, which are not only periodically conducted by emergency organizations but also by other organizations that may deal with emergencies. Among the authors of the "Introduction to Emergency Management" manual, Haddow and Bullock, who were the former deputy chief of staff and chief of staff at FEMA, respectively, provided an authoritative definition of what an exercise is at FEMA: "A controlled, scenario-driven, simulated experience designed to demonstrate and evaluate an organization's capability to execute one or more assigned or implicit operational tasks or procedures as outlined

in its contingency plan" (Haddow et al. 2010, p. 112). The aim is to train "timing, coordination, communication, roles, and responsibilities" (Alexander 2002, p. 289), and more precisely, to train operations to "be conducted efficiently in order to shorten emergency-response times in real emergencies" (Alexander 2002, p. 298). However, within this objective, targets can be differentiated according to the scope of the exercise and the expertise of the participants. In addition, each participant in the exercise may be assigned with diverse targets that vary according to the understanding of the linear progression of operations (e.g., from hazard analysis to recovery), the acquisition of peculiar skills (e.g., hazard analysis or resource management) and the assessment of the competencies to face practical situations (Alexander 2002).

Exercises can also vary according to focus (i.e., one's operations to a complete set of operations), involvement of individuals (i.e., specialised teams to all response officers), and situation realism (i.e., from stylised paper scenarios to mimicking actual disasters). The most common type of exercises include (Coppola 2011): drills, which are controlled situations in which a single operation is practiced and assessed; tabletop exercises, which are low-stress discussion scenarios in which officials practice the activation of the emergency response plan; functional exercises, which are simulations in which a full range of operations are tested together to fulfill a greater overall response purpose; and full-scale exercises, which are scenario-based events that mimic the atmosphere and the events of an actual disaster. In this case, the players act in real time with actual equipment and procedures.

5.7.2 Improvisation and Bricolage

Response to emergencies may also occur through improvisation. Improvised responses are ad hoc responses that adapt to the occurring events in which the design and execution of novel solutions are fused in the same moment (Miner et al. 2001).[8] The concept of improvisation builds on the typical temporal separation of conception and execution (Cunha et al. 1999; Moorman and Miner 1998), and it is defined by their instantaneous convergence triggered by the moment (Ciborra

1999; Weick 1998). In fact, external time pressure increases the probability of improvisation (Miner et al. 2001).

Research has shown that HROs "respond to new conditions in an emergent manner" and through improvisation, they provide adaptation and a "responsive form of real-time organizational learning" (Bechky and Okhuysen 2011, p. 240). In improvisation, both change and design are combined into the unique creation of action that is built on the reworking and recombination of available resources/solutions, such as "pre-composed material and designs" (Weick 1998, p. 554), to meet new needs or solve new problems (Baker and Nelson 2005). The term "*bricolage*" has been used to explicate the way in which improvisation takes place (Ciborra 1994, 1998; Moorman and Miner 1998; Weick 1993; Cunha et al. 1999).[9] In the Mann Gulch accident in which the majority of the team of expert firefighters died, Weick (1993) argued that those who survived were able to creatively recombine their knowledge and operating procedures, thus utilizing a paradoxical recombination of tools and practices that typically serve opposite purposes. For instance, while escaping the fire behind him, the chief officer provoked a fire in front of him and jumped through the fire. Through this approach, when the fire reached his position, it did not find any combustible material and as a result, he was saved.

Miner et al. (2001) identified the taxonomy of three types of improvisation outcomes (i.e., sequences of behaviours, artefacts and interpretations), which has become mainstream in the literature (Hadida and Tarvainen 2014), and the so-called "instrumental referents" such as problems, temporal gaps and opportunities that both anchor and constraint improvisation. The outcome of improvisation may be either good or bad, but in any case, it concerns an emergent deployment of actions that are situated (Suchman 1987) and whose overall comprehension only occurs when an action is completed. For instance, Hutchins (1991) described how the ship's navigation team reacted to a failure of the navigational system during the complex manoeuvre of entering a harbour. They spontaneously calculated the data in order to allow the navigation directions to find an emergent working coordination solution. However, no individual member of the team was aware of the overall outcome of improvisation; that is, no one "fully grasped the

system he or she was creating or why it was working" (Moorman and Miner 1998, p. 704).

The question concerning why and when people improvise has interestingly been addressed by Vendelø (2009), who combined reflections offered by Ciborra (2000), Miner et al. (2001) and (Cunha et al. 1999). In general, organizations improvise when they perceive unexpected situations under the following conditions: (1) those that take them by surprise; (2) those for which they do not have any designed or "preplanned" sequence of actions; and (3) those that require immediate reactions.

In regards to material improvisation, Weick (1993) showed that the previous experience of firefighters played a prominent role in supporting successful (or unsuccessful) improvisation. Moorman and Miner (1998) suggested that organizational memory impacts improvisation through two components: procedural memory, concerning skills or routines, which supports improvisational effectiveness and speed but reduces improvisational novelty; and declarative memory, concerning more general knowledge of facts, events or propositions, which enhances improvisational effectiveness and novelty but reduces speed.

During improvisation, the attitude that characterises players is of "ritualized ingenuity" (Coutu 2002) towards the practices and the resources that they can rely on, which is a property that is often overemphasised (Vera and Crossan 2004; Flach 2014). In fact, they are familiar with the practices and the resources that they improvise on, but they see and use them in ways that diverge from the usual approach. Moreover, Duymedjian and Rüling (2010) claimed that the availability of familiar objects and the possibility of performing simple actions though them trigger the immediate response under trial and error, and allows experimentation in order to avoid paralysis.

Improvisation also involves organizational structure. HROs display "underspecified" structures (Weick et al. 1999) that reassemble according to the situation. When events overcome normal operational boundaries, HROs enact a structure that approaches the garbage can model (Weick et al. 1999). In the garbage can model of problem solving (March and Olsen 1986), problems and solutions are independent elements flowing through the system, and their matching is defined

by their arrival and departure times; that is, by their joint presence in the same moment in the organization. As a result, in HROs, the decision makers are identified not by hierarchy, but by their competency. In aircraft carriers, for example, this structure results in the emergence of ad hoc "epistemic networks"; that is, ad hoc networks of "solvers" that are created for the purpose of providing more adequate solutions and that dissolve as soon as the problems are solved (Weick et al. 1999). Moreover, improvisation also occurs when there are no organizations to remodel, according to the situation. Lanzara (1983) described that, in the aftermath of a large earthquake, "ephemeral organizations" arose to meet the peculiar needs of the situation.

Some recent contributions on improvisation (Magni et al. 2009, 2013 Magni and Maruping 2013; Vera et al. 2014) investigated what team peculiarities support improvisation and under what conditions. Magni et al. (2013) addressed the role of team dispersion, both physical and psychological, and found that higher team member dispersion negatively impacts improvisation since it hampers the timely access to members' knowledge and real-time interactions that may lead to improvised creative solutions. Magni and Maruping (2013) also showed that empowering leadership positively moderates the improvisation-performance relationship when overload is low, whereas it is detrimental when overload is high. Moreover, Magni et al. (2009) added that team behavioural integration and team cohesion positively affects individual improvisation. Vera et al. (2014) found that the relationship between shared understanding of new knowledge and improvisation capability is strengthened by the so-called "minimal structures" (Kamoche and Cunha 2001), "simple rules" (Davis et al. 2009), "higher-level principles" (Frigotto et al. 2014) and "semi-structures" (Brown and Eisenhardt 1997); that is, "macro routines and high-level parameters that combine '"loose"' elements of freedom with '"tight"' elements of control (Kamoche and Cunha 2001)" (Vera et al. 2014, p. 11) and are deployed at the micro level. Finally, Akgün and colleagues (Akgün et al. 2014) found a positive relationship between environmental turbulence, team unlearning and team improvisation, thus stimulating a reflection on the nature of improvisation as the emergent production of creative

solutions and its relationship with the instantaneous forgetting of unsuccessful improvised solutions.

Miner et al. (2001) posed the question of whether organizations can plan such an unplanned event as an improvisation. The motivation for organizations may be found in the reduction of improvisation (Cunha et al. 2015). However, improvisation is also artificially produced within organizations. They also showed that organizations develop specialised competencies in generating and deploying improvisation, and that improvisational activities can become routines whose actual contents are not designed in advance. For example, in their analysis of product innovation processes, they found that peculiar time slots were devoted and team compositions were orchestrated to provide new products.

5.8 Integration

The integration of recognition and response in an organizational system that is able to deal with both new and known emergency situations requires one to manage the trade-off between the high pressure of results, which is also motivated by the high stakes involved in emergencies—that is, human lives—and time shortage (and resource shortages in general). When a new emergency occurs, such a trade-off is reflected in a twofold situation. First, the result is not guaranteed since it is impossible to wait until the situation is understood and controlled in order to activate the most suitable response. In fact, the situation typically deteriorates over time to a point where it is no longer recoverable. Second, while known emergencies are addressed through a perception and response that are part of an automatic (or semi-automatic) process in which each stored situation corresponds to a well-known response, perception and response to new emergencies require emergency management organizations to engage in a recursive search for sense, where neither the result nor rapidity is guaranteed. In this case, the questions asked tend to focus on perception and response, such as "what is happening?" and "what can we do?" In the literature, such a trade-off is addressed in terms of resilience and efficiency.

Organization studies have long focused on the problem of understanding the possibility of pursuing efficiency and resilience simultaneously (Frigotto and Zamarian 2015). Resilience refers to the ability to survive sudden shocks and to rapidly return to normal operation (Comfort et al. 2010). However, the literature has clarified that resilience is hardly compatible with efficiency (Roberts et al. 2001; Eeten (van) et al. 2010), as shown, for instance, by the Mars Climate Orbiter Mishap Investigation Board, which concluded that several mishaps in space missions were incompatible with the so-called Faster, Better, Cheaper (FBC) policy adopted at NASA (Woods 2006).

At the micro level, such a trade-off is deployed between mindfulness (Weick et al. 1999) and routines (Winter 2004; Nelson and Winter 1982). Organizational mindfulness is "the quality of collective attention that enables managers and employees to minimise errors, remain vigilant, and respond effectively to unexpected events" (Rerup and Levinthal 2014, pp. 33–34). It includes the quality of attention, the consequence of attention—that is, "what people do with what they notice" (Weick et al. 1999, p. 90), and the conservation of attention. Mindfulness also supports organizations to be continuously alert and more receptive of early signals of trouble (Rerup 2005), to track small failures, to resist over-simplification, to remain sensitive to the operations in practice, and to define responsibility of decisions on expertise, rather than on authority (Weick et al. 1999). Conversely, the explorative and non-automatic nature of mindfulness is challenged by routines. As organizations attempt to stabilise responses and standardise behaviours, they also narrow the scope of attention and other resources (i.e., time and effort) devoted to single instances. Consistently, routines have traditionally been conceived as mindless (e.g., Langer 1989; Ashforth and Fried 1988). In fact, people generally follow routines without devoting cognitive attention to them, and they economise cognitive resources by executing them in the realm of unconscious (Becker 2004).

Empirical work has shown that routines also include non-automatic cognition (Pentland and Rueter 1994), since people do not simply recall and reproduce them, but they have the choice to amend them and decide how to perform such routines. Building on this evidence, recent contributions have attempted to reconcile mindfulness and routines,

claiming that organizational mindfulness can be embodied in routines (Levinthal and Rerup 2006).

On the one hand, routines can foster organizational mindfulness in several ways. First, they can help set expectations that stimulate people to increase their attention towards threatening cues of variation (Rerup 2009; Weick and Roberts 1993). Second, they can help deploy mindful principles, at the micro level, in everyday practices (Rerup 2009). Third, they can help build the repertoire of behaviours that the organization (or the individual) can draw upon and recombine in response to unexpected situations (Bigley and Roberts 2001; Weick and Sutcliffe 2001).

On the other hand, routines can also hinder mindfulness for at least two reasons. First, routines typically restrict the focus of attention to experienced conditions, rather than signals of change. In fact, routines primarily store efficient solutions to frequent situations, and such solutions often become institutionalised or standard operating procedures (SOPs). However, mindfulness supports the attitude to discuss each variation from the standard case, since it would reveal a different nature of the case itself and imply a challenge. Thus, when mindfulness becomes routine, its typical receptiveness and openness to variations decreases as the selective "eye" and the ability to deploy solutions strengthens. Second, routines are of higher value in stable conditions; that is, they have proven to be reliable in the past and they imply a low cost of implementation and search. Conversely, mindfulness implies higher implementation costs ceteris paribus. However, contexts and situations in which there are no similarities between the future and the past, and where there are high costs associated with failure, are the main motivations for mindfulness.

5.8.1 Integration as a Sensor-Reactor System

The literature has not been so generous in providing contributions clarifying how the combination of mindfulness and routines may function in empirical contexts or what components/properties form such a combination. Frigotto and Zamarian (2015) claimed that the contrasting goals of resilience and efficiency can be reconciled by considering

two lines of thought. On the one side, there is the recombination of the building blocks of mindfulness and routines, which includes resilience and efficiency, respectively. On the other side, there is the process through which these building blocks are activated, meaning both their activation in time (sequent or concurrent) and their interaction. Winter (2004) conceptualised organizations into evolutionary systems of sensors and reactors that allow us to further deploy these two lines of combination.

Winter (2004) described organizations as extremely analogous to biological organisms. Organizations are endowed with a set of "sensors", tasked with monitoring the environment, and "reactors", devoted to producing a response to the perceived stimuli. Within inexperienced organizations, sensor-reactor systems generally address a broad range of stimuli, thus providing broad, sometimes ineffective, responses. Then, evolution, through experience, produces specialisation and efficiency, when relevant environmental signals are repetitive and associated solutions become clear, stable and secure. Over time, specific sensor-reactor systems for frequent and relevant situations are identified, and they are substituted for general systems. This occurs according under two conditions: (1) the frequency and the variety of stimuli that the organizations are exposed to; and (2) the impact (in terms of wins/losses) of facing such situations, through a cost-benefit analysis, based on the assessment of risk (combining frequency and impact). However, the tendency is to build specialised sensor-reactor systems and to keep general sensors only for residual situations in which the specific reactions and solutions cannot apply. At the extreme of efficiency, general sensors are completely abandoned, thus rendering organizations unable to effectively respond when new or infrequent cases arise.

Various systems address different sets of stimuli. For example, specialised sensors capture known situations and activate specialised responses, while for new challenges or unusual ones, general systems are in place. Table 5.3 provides an overview of the two types of sensors and reactors as well as illustrates that, while general sensors are flexible in the short run and they can easily be redeployed, specialised sensors provide rapid and reliable responses. In order to discuss their criticalities, Winter (2004) offered the following metaphorical example. Some species of

Table 5.3 Specialised and general sensor-reactor systems

Type of sensor-reactor system	Range and scope	Flexibility	Redeployability	Lead time from signal to action	Critical issues
Specialised	Narrow	No	Difficult	Rapid	Focus on the past
General	Wide	Yes	Yes	Slow	Long search, untested responses

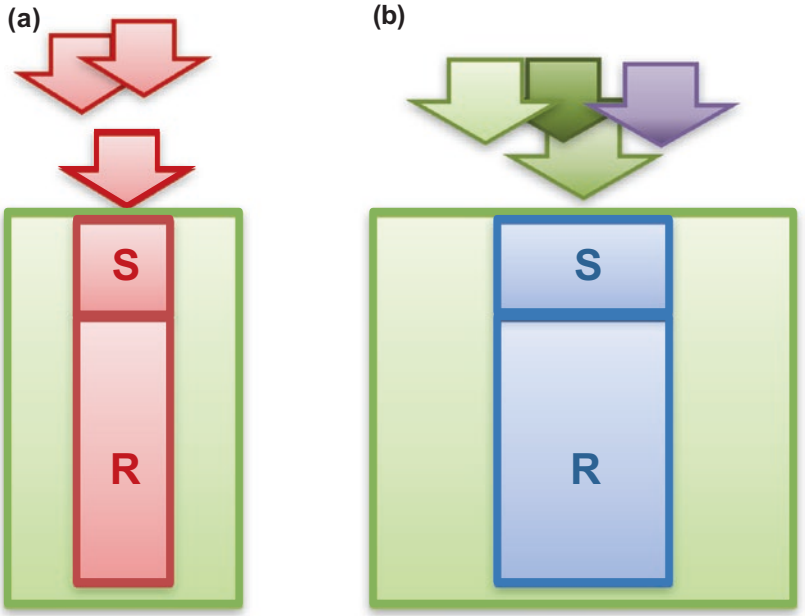


Fig. 5.2 Specialised and general sensor-reactor systems

moths have developed an extremely sophisticated detector (similar to sonar) for perceiving the vibrations of bats' wings (bats being their major predators). As a result, such moths can employ an evasive dive manoeuvre to escape. This is also an example of a highly specialised sensor-reactor system (Fig. 5.2a). Specialised systems are more efficient and are extremely effective for reacting to the type of stimuli for which they were designed. However, they are extremely vulnerable to other conditions. For example, since moths cannot hear anything else aside from

Table 5.4 Matrix of systems and situations

Type of system (rows) vs. Type of situation (columns)	Standard (known)	Other (unknown)
Specialised	Ok	System failure (type I error)
General	Resource waste (type II error)	Ok

the vibration of bats' wings, they can be easily killed with a rolled newspaper. From the same natural context, Heiner's (1983) representation of prey behaviour may be a good metaphor for general sensor-reactor systems (Fig. 5.2b). In response to any signal coming from the environment, which is not immediately recognised as a mate or food, most prey generally activate the same reaction; that is, they flee. Generic systems are less precise and thus, they are costly, since their reaction is unnecessary in many cases; that is, when unusual noises do not originate from threats. Nevertheless, they have a higher possibility of responding to uncertainty, and they always provide some type of response. As such, they display resilience.

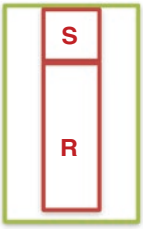
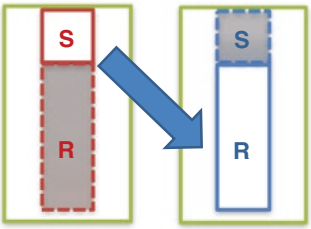
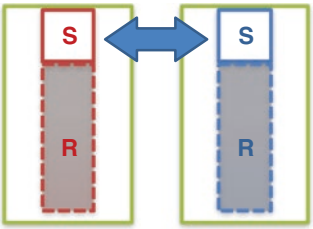
The activation of the specialised sensors or reactors when the situation is standard, and the activation of the general sensors when the situation is new, concerns the inadequate understanding and response of the case that may lead to failure. The decision on the activation of general or specialised sensors is ruled by the typical Type I and Type II errors of statistical hypotheses testing. A Type I error concludes that a situation is peculiar, even though it is not, while a Type II error concludes that the situation is standard, even though it is not. In the first case, resources are wasted, but resilience is high, whereas in the second case, resilience is at risk and disaster is likely, while efficiency is respected. Table 5.4 illustrates this trade-off.

5.8.2 Possible Combinations

Given the internal and external complexities, the two general and specific systems typically coexist in organizations (Cohen and Levinthal 1990; Denrell and March 2001; Levinthal and March 1993; March

1991; March 2006; Winter 2004). Frigotto and Zamarian (2015) analysed the aerial practices of Sixth Wing in the Italian National Air Force, called the "Red Devils", which fly both combat and recognition missions. In their empirical observations, they identified three main combination patterns (see Table 5.5). The first concerns combinations of sensors and reactors at the same degree of specialization, referred to as *vertical combinations*. A successful flight relies on the correct execution of a set of responses to the perceived, relevant, state of the situation. This coupling is codified into standard operating procedures

Table 5.5 Combinations of the sensor-reactor system

Sensor–Reactor combination	Description
 Vertical: linear Sensor to Reactor	Condition—action pure matching; rule-based action
 Diagonal: Sensor to Reactor	Combination of sensors with reactors usually associated with different sensors
 Horizontal: Sensor to Sensor or Reactor to Reactor	Interaction of sensors or reactors to provide a broader but also specialised scope

(SOPs) detailing activation conditions and step-by-step descriptions of the actions to undertake in order to correctly respond to the situation at hand. Crewmembers are required to memorise and internalise the so-called "bold faces" of each procedure before they are allowed to fly missions. In this regard, bold faces consist of limited lists of actions designed to stabilise the situation, thus giving sufficient time for the navigators to consult the physical copy of the avionics or emergency checklists that they carry in their suits. These *vertical combinations*, provided to all crewmembers through contingency procedures, are implemented with no appreciable difference between experienced and novice crewmembers.

The second combination concerns the *diagonal sensor-reactor system*, which is only available to expert crews since they are able to decouple the vertical combination of sensors and reactors typical of SOPs and recombine them in cases where contextual conditions suggest the possibility of transferring a procedural response from one domain to another. This combination represents creative associations between a sensor that would usually activate a certain reactor with a different one. The "Red Devil" crewmembers do not have a word that describes this combination. Instead, they refer to it as a smart solution to an extremely difficult problem. For instance, when the alarm panel is signalling an engine failure, the standard reaction consists of switching off the damaged engine and continuing the flight with the remaining engine. However, experienced crews consider an alternative explanation for the pattern of lights; that is, when one of the engines overheated, corresponding alarm lights did not switch on since the sensors have melted, while the alarm lights of the working engine switched on due to the heat reverberating from the other one. In this situation, following the book would mean switching off the only functioning engine and to send more fuel to the overheated one, thus provoking an explosion. The out-of-the-box solution consists of testing the alarm panel for anomalies by adopting a typical trivial lights check in which they manually switch the alarm lights connected to each engine to determine if they did not turn on since the light was broken. This allows the crew to adjust and select the correct response among the available ones.

The third case concerns a *horizontal combination of sensors and reactors*. Flying a Tornado aircraft is a complex activity that requires the integration of a large set of sensors that monitor the condition of the aircraft, the proximity to the target, meteorological conditions, air traffic conditions and the interaction between the pilot and the navigator. The "S.A."; that is, situational awareness, represents the capability of handling these sensors through the correct allocation of attention and prioritisation of incoming information. This ability is acquired through experience, and there is no precise indication on how to acquire this skill. S.A. represents a synthetic sensor combining the discrete sensors available to the crew. However, it is not a complex set of procedures, which would always be inadequate to unforeseen and unknown situations. Instead, it is the endowment of simple and general-level principles that give the crew the responsibility to find proper solutions, while providing the contextual conditions for this to occur. For instance, S.A. allows the crew to gain time to assess specific situations, and it also provides reassurance, which is necessary to support certain actions. The horizontal dimension can be mapped as the concurrent activation of sensors constituting S.A.. Similarly, the concurrent use of basic rules, with avionic and emergency checklists, is an example from the realm of reactors. Moreover, the horizontal combination of sensors or reactors is clear to both expert and novice crews since it is formalised. Rochlin (1997) found a similar combination of sensors in the combat operations centers of U.S. Navy ships, which use the term "*having the bubble*" to refer to the ability to integrate diverse information sources regarding the status of the ship and its weapons into a picture of the situation that can absorb small variations and provide real-time adaptation.

5.8.3 The Dynamics

In the Tornado aircraft, various sensor-reactor systems of different levels of specialisation coexist, which is typical of complex systems. This evidence is in line with the literature, predicting that, in complex environments, organization systems do not typically evolve into highly specialised systems devoted to univocally addressing peculiar environments,

but they include both general and specialised systems (Winter 2004). The concurrent activation of components as well as the sequence of components, for example, through the horizontal combination, achieves both resilience and efficiency. It is also achieved through the parallel activation and combination of sensors and reactors at different degrees of specialisation as well as through their sequence. These two mechanisms not only allow the efficient and rapid deployment of responses, but also the continuous reassessment of the situation. In fact, on the one hand, routines impose the concurrent use of general and specialised sensors or general and specialised reactors. On the other hand, such combination supports efficiency that "buys time" for adaptation; that is, the necessary time for the adaptation of sensors and reactors to a specific situation.

In the literature on emergency management, Rudolph and Repenning (2002) showed that people activate two different approaches when they deal with known situations or when they deal with novel emergencies. However, their fallible ability to recognise which situation they are facing makes them activate the wrong approach, which results in failure or disaster. At the individual level, they used a computer simulation to examine a sample of decision makers that use one or the other approach, and whether it leads to success or failure. Chen et al. (2008) proposed a framework to analyse coordination patterns in emergency operations. They identified two distinct coordination patterns that coexist in emergency operations that are extremely different and rely on different time availabilities. On the one hand, there is the "mini-second coordination cycle" in which perception and response are rapid and reactive. On the other hand, there is the "many-second coordination cycle" that addresses all of the available information and is oriented towards the quality of the decision, rather than its speed. In addition, they modelled the activation of such systems as concurrent, thus implying that rapid and standard operations are activated and complex problem solving and research are performed. Even if they do not further elaborate on the dynamic activation of such systems, they suggest the existence of another type of dynamics; namely, the concurrent activation of specialided sensor-reactor systems and general sensor-reactor systems. Since this achieves reliability and prompt intervention, emergency

organizations have also been defined as effective "fast-response" organizations (Faraji and Xiao 2006).

5.9 Learning for Novelty: Addressing the Oxymoron

Emergency management and new emergencies, in particular, provide a challenging field for learning. First of all, the usual ways that organizations adopt learning are not viable in emergency management. For example, trial-and-error learning is only a limited possibility (LaPorte and Consolini 1991) since the contexts in which emergency organizations operate are so high risk that an error would have devastating consequences for the function and life of the social system (Rochlin 1999). Moreover, while learning is, in nature, the inclusion of novelty into the realm of knowledge, so that what is new transforms through learning into something known (Levinthal 2008), the same method applied to new emergencies does not provide the necessary knowledge to face the *next* new emergency. Conversely, it provides knowledge about the *last* new emergency that occurred, and it does not endow organizations with better abilities to face the "unthinkable" in a future emergency.

This section analyses one of the biggest opportunities of learning from new (recent) emergencies, both in terms of resources and attention: the 9/11 terrorist attack. Then, it considers the learning practices from the literature and the HROs that support a new idea of learning, where novelty is not included into knowledge once it has occurred but how it is perceived when revealed. These contributions aim at understanding how the "unthinkable" can be addressed earlier, and whether there is a way to prepare for such a situation. As such, these practices challenge the oxymoron of "thinking the unthinkable" or "expecting the unexpected".

5.9.1 Learning Post-Mortem

The 9/11 terrorist attack is an exemplar of new emergency and a case of extreme novelty. It changed the way people think of their lives as well as

the way governments conceive security and safety. Learning from such event has been as prominent as dramatic was the impact it has had on society. After the attack on the World Trade Center in New York, many stakeholders began focusing on what they could learn from the disaster. During and after the attack, a considerable number of images, videos and writings were made available to the public for three purposes: (1) to clarify the facts; (2) to understand if everything possible had been done for effectively preventing and responding to the first attack on U.S. soil; and (3) to determine if something more can be done to defend the country from possible attacks in the future. Televisions, newspapers, authors, directors and even laypeople (see YouTube home videos) have offered their various perspectives on the tragic event.

Meanwhile, the scientific community offered studies on various aspects of the crisis rooting the discussions in the most differentiated streams. Limited to emergency management, the various contributions mirrored the wide array of issues that the attacks raised. For example, the studies included: general preparedness of the country (Sattler 2003) and predictability of the attack (Parker and Stern 2002, 2005; Porch and Wirtz 2002), effectiveness of the response in terms of distribution of responsibilities among the federal government (Cohen 2003), and public/private spontaneous/structured operations. Specifically to health care, authors discussed the preparedness of the system (Mattox 2001) and the management of emergency sites (Bradt 2003). In addition, relevant to emergency management is the study of 9/11 patterns of citizens' responses to disasters (Perry and Lindell 2003), volunteer behaviours (Lowe and Fothergill 2003), safety (Reissman and Howard 2008), and victim management (Simpson and Stehr 2003). Several scholars (Silver et al. 2002; Liverant et al. 2004; Galea et al. 2002; Schuster et al. 2001) studied the psychological distress that typically follows disasters. In particular, Hammond and Brooks (2001) focused on helpers, and proposed strategies of stress management that should be incorporated into disaster management plans. Finally, some scholars analysed the impact of the 9/11 terrorist attack in managerial contexts for companies based in the World Trade Center itself (Greenberg 2002) and other related aspects such as employee absenteeism (Byron and Peterson 2002) and the restoration of operations (Argenti 2002; Beunza Ibáñez and Stark 2005; Kelly and Stark 2002).

An interesting set of contributions for the purpose of this book discuss information in relation to spatial proximity to a crisis event (Spence et al. 2005), information duration (Michaels 2003), information sharing (Kramer 2005; and Alavosius et al. 2005), and inter-organizational coordination, which is typical of multi-agency emergency operations (Comfort and Kapucu 2006). Moreover, improvisation and resilience have been investigated by a group of scholars from the University of Delaware and their colleagues (Kendra and Wachtendorf 2003a, b; Wachtendorf 2004; Trainor 2004).

In addition to these analyses, the U.S. government and the emergency organizations involved in the aftermath of the 9/11 terrorist attack on the World Trade Center invested millions of dollars in order to understand the mistakes that had been made and what lessons could be learned from the disaster. They aimed at clarifying to what extent such an event could have been anticipated and if the reactions of the emergency management organizations had been adequate, with the final purpose of defining a new emergency management plan that would include the lessons learned. All of these reports resulted from the analyses of interviews, written documents and recorded communications that occurred at the time of operations (Table 5.6).

Chronologically, the first issued report was developed at the micro level, which concerned two organizations that had been directly involved in the emergency response. It was the result of a consulting project performed by McKinsey & Company and commissioned by the police and fire departments of the City of New York (PDNY and FDNY). More precisely, two reports were issued in 2002 (one under the FDNY request, and the other under the PDNY request), with the aim of increasing the preparedness and response abilities of these organizations.

A more general perspective regarding the problems and responsibilities of individual emergency organizations and their systems was provided by the U.S. Congress 9–11 Commission Report (released in 2004) and edited by an independent and bipartisan commission that conducted official interrogations and data collection. In addition, the National Commission on Terrorist Attacks upon the United States examined the "facts and the circumstances" of 9/11 (p. XV),

Table 5.6 Official reports on 9/11

Title of report	*Increasing Fire Department New York Emergency Preparedness and Response*	*Improving New York Police Department Emergency Preparedness and Response*	*Saving City Lifelines: Lessons Learned in the 9–11 Terrorist Attacks*	*The 9–11 Commission Report*	*The Emergency Response Operations*	*Information, Technology, and Coordination: Lessons from the World Trade Center Response*
Editors	City of New York		MINETA Transportation Institute	National Commission on Terrorist Attacks upon the United States	National Institute of Standards and Technology (NIST)	Center for Technology and Government (CTG)
Authors	McKinsey & Co.		Jenkins & Edwards-Winslow		Lawson & Vettori	Dawes et al.
Year of release	2002		2003	2004	2005	2004
Focus	Enhance the FDNY's preparedness	Enhance the PDNY's preparedness	Transportation	Intelligence, border control, diplomacy, immigration, law enforcement, responsibility among Emergency Agencies	Assessment of protocols, guidelines and practices activated during operations; failures of technologies and impact of structural peculiarities of WTC	Information needs, resources technology, and policies with reference to planning, preparedness, coordination, and collaboration during the emergency among the involved organizations
Data	100 interviews with FDNY personnel; other interviews conducted by the Department internally; dispatch records and about 60 h of communications tapes		Interviews with transit authorities and public officials, written plans made before the events and reports completed after	19 days of hearings, public testimony of 160 witnesses, 1600 interviews, 2.5 million pages of written documents	Written documents, electronic recordings, visual data (photographs and video) and first-person interviews.	29 interviews with people representing city, state, federal government agencies, private businesses, and non-profit service organizations.

(continued)

Table 5.6 (continued)

Title of report	*Increasing Fire Department New York Emergency Preparedness and Response*	*Improving New York Police Department Emergency Preparedness and Response*	*Saving City Lifelines: Lessons Learned in the 9–11 Terrorist Attacks*	*The 9–11 Commission Report*	*The Emergency Response Operations*	*Information, Technology, and Coordination: Lessons from the World Trade Center Response*
Recommendations (focus on EM)	Create a specialised command and control team for major incidents, with clear and consistent responsibilities and roles. Develop, expand and update procedures and exchanging operational information with other agencies. Better technology and communications equipment and infrastructure	Clearer delineation of roles and responsibilities of leaders and of the chain of command. Define radio communications protocols and procedures. Disseminate information. Counter-terrorism training provided regularly. Comprehensive disaster response plan and procedures	Increase crisis planning and frequent response exercises.	Information procedures should provide incentives for sharing information. Redesign specialization and coordination of governmental agencies for better security and intelligence	Several limitations in building's structural emergency system and lack of standards in defining them; lack of preplanning and of necessary communication technology; difficulty in establishing a unified command system	Build emergency programs for government, businesses, and civic organizations as an interdependent system. Invest in information quality and usability, in community mobilization practices

with significant attention on intelligence, border control, diplomacy, immigration and law enforcement as well as the division of labour and responsibility among American agencies.

At the system level, several reports were edited by governmental agencies, each focusing on peculiar aspects of the overall response. In 2003, the Mineta Transportation Institute (MINETA) Report, written by Jenkins and Edwards-Winslow, was issued. It provided an analysis regarding the way that transit systems responded to 9/11 and how the Office of Emergency Management (OEM) coordinated response and recovery operations. The Center for Technology and Government Report (CTG) (Dawes et al. 2004, p. 1) studied how 9/11 "information needs, resources technology, and policies interacted with planning, preparedness, coordination, and collaboration during the emergency among the involved organizations". The National Institute of Standards and Technology (NIST) edited nine reports (the last one in January 2009) that investigated the collapses of World Trade Center Buildings 1, 2 and 7, and provided an analysis of the structural integrity and fire endurance of the structures as well as the fire protection systems and building evacuation and emergency response procedures. Furthermore, the Nr. 8 NIST Report by Lawson and Vettori (2005) analysed emergency responders' operations, the technologies used, and the guidelines/practices that they followed.

Concerning the organizational response to the 9/11 terrorist attack and the recommendations for increasing preparedness, the reports seem to converge in highlighting the following main problems: organizations do not use all available information; they do not circulate enough information; and communication technology and procedures did not suit the coordination and organizational needs of multi-agency operations. In short, the lessons learned for the future were that agencies need to be linked with one another and information must be effectively disseminated.

After the release of these studies, institutions accountable for emergency management took in the recommendations and proposed new procedure manuals, modified internal structures, and enhanced interagency standards. In 2004, the National Incident Management System (NIMS) was issued, which defined national emergency management

according to a platform of standardised resources, activities and organizational structures that were flexibly combined to respond to emergencies. In 2006, the FEMA Principles of Emergency Management was released, which prescribed how to manage critical activities such as the exchange of information or the definition of hierarchical control.

However, none of these manuals considered that the emergency itself can be either irregular or "unthinkable". In fact, words such as "*surprise*", "*new*", and "*unexpected*" do not appear in any part of the manuals. In the NIMS, for instance, the phase devoted to understanding the situation is the first of five steps in the planning project, but it is depicted as an unproblematic phase that is periodically revised when further information becomes available. Activities mentioned for this phase include gathering, recording, analyzing and representing information. It also discussed how the effectiveness of interpreting the situation relies on the mechanisms adopted, which guarantee both a clear picture of the magnitude, complexity and potential impact of the incident and the ability to determine the resources required to develop/implement an effective incident action plan. The fact that the emergency can be hardly perceived, for instance, since it is caused by something completely novel or unexpected does not seem to be relevant, since sensemaking is not even mentioned as a phase of the emergency management process.

Overall, these reports are more directed at correcting existing procedures and endowed technologies, rather than focusing on the inherent limits in the traditional concept of preparedness. It can be considered indicative that, in 2005, facing the adoption of the New Terrorism Response Plan for the City of New York, Peter Hayden, the head of the FDNY, stated that, despite the efforts and considerable resources, this "recipe for disaster" does not leave the city better prepared for a terrorist attack than it was on the eve of September 11, 2001[10] (interview reported in *The New York Times* on April 22, 2005).

5.9.2 Learning from Expanded or Enriched Experiences

One of the greatest obstacles to learning from new emergencies is derived from the difficulty in considering them as "samples of one or

fewer" (March, et al. 1991) or as events that are unprecedented and unexampled. The consideration of new emergencies within such a category is difficult since, for the hindsight bias, after such events have occurred, they are considered to be far more predictable than they actually appear. Thus, learning is focused on how to correct errors that occurred in the prediction process, rather than discussing predictability and learning how to deal without this aspect (March and Goitein 1984). This change in perspective is what hampers effective learning and progress in response to such cases (Goitein 1984).

Such resistance is also due to the fact that learning from "samples of one or fewer" is not, per se, an easy task. It is actually the opposite of what organizations typically achieve. In addition, it is in contrast with the way knowledge is conceived and expanded, such as through repetitive observations. March et al. (1991) highlighted several strategies that organizations can adopt to learn from "samples of one or fewer". For example, Weick and colleagues (Weick et al. 1999; Weick and Sutcliffe 2001) collected observations from the experiences of HROs that validate, exemplify and specify some of the strategies.

The main issue concerning unique events is that they lack knowledge to interpret them. In fact, in order to be able to interpret any event, it is necessary to have knowledge about the distribution from which it was drawn. According to March, Sproull and Tamuz (1991), learning strategies concern the methods that organizations use to expand knowledge. Since knowledge based on experience (occurred similar events) is not available, such strategies build on imagined realities and the enrichment of individual experiences.

First, organizations engage in the exercise of supposing how events would have occurred by imagining slightly different circumstances. March et al. (1991) identified this strategy as *near-histories*, also referred to by other authors as *near misses* (Weick et al. 1999), *near-failures* (Kim and Miner 2007) or *might-have-been scenarios* (e.g., Morris and Moore 2000).[11] Through this strategy, organizations learn more about the events that they have faced and any cues that may have been revealed. They probe an implicit distribution of the phenomenon that might include the observed outliers. For example, in the Italian Air Force, crews report "flight setbacks", which are events that (under

slightly different circumstances) would have evolved into an accident, after which they organize weekly meetings where they discuss what occurred and how they can learn from such circumstances (Frigotto and Zamarian 2015). Interestingly, Morris and Moore (2000) specified that not all imaginative histories accomplish the learning objective. They also showed that only reasoning that included language and words regarding the self (not others) can support learning.

Second, organizations build *hypothetical histories* of which near-histories can be seen as a special case. They use "small pieces of experiences in order to construct a theory of history from which a variety of unrealised, but possible, additional scenarios are generated" (March et al. 1991, p. 5). Artificially, they build their imaginary problems and explore different alternative scenarios in order to learn how new situations could appear. For example, in the military, spreadsheets or systems of equations that portray organizational relations are used to think about the future. They also provide "stories" that are also "visible" as imaginary "pictures" of the mission (Frigotto and Zamarian 2015).

Third, organizations elaborate on *histories of actual errors* that have been committed. In this regard, HROs encourage and reward the reporting of errors, and they do not stop at the first direct cause of the mistakes, but they attempt to elaborate on the chains of causality that have provoked them (Weick et al. 1999). These histories serve for enriching the knowledge regarding events that have occurred, but whose numerousness is too low to elaborate in the conventional manner. Since the multiplication of events is not possible, which is normally the necessary condition for learning, organizations "enrich" their experiences (March et al. 1991) by acquiring knowledge from actual cases that they have experienced.

Fourth, another way of enriching experiences is by *multiplying observers* of the same experience (March et. al. 1991). In this case, HROs cultivate diversity of members in order to internally replicate the variety that they face externally. Divergence in analytical perspectives regarding situations or patterns of action "provide[s] the organization with a broader set of assumptions that sensitise it to a greater variety of inputs" (Weick et al. 1999, p. 95). In this way, different perspectives on the same reality allow an organization to know more about an event.

Through these learning strategies, organizations attempt to expand the set of events and causalities that are deemed possible by enlarging the range of their expectations. The aim is not anticipating surprises through the precise forecasts of their manifestations, but creating "latent expectations", which would make the recognition of the occurring events possible and adaptation feasible.

Notes

1. This author wishes to thank Matteo Vischi of the Civil Protection South Tyrol for making this apparent.
2. Response aims at reducing or eliminating the impact of disasters, while recovery concerns the reconstruction and restoration of normal life. See Coppola (2011) for a more detailed description of the phases of modern disaster management.
3. During preparation, those who may be impacted by a disaster or who may be able to help those impacted are equipped with adequate tools. Mitigation is also called "prevention" or "risk reduction", and it is aimed at reducing the likelihood or the consequences of a hazard before a disaster occurs (Coppola 2011).
4. http://www.fema.gov/about-fema, last visited June 12, 2014, emphasis added.
5. For example, regular events include seasonal or other repetitive events for a geographical area, such as hurricanes or floods, as well as infrequent events, such as volcanic eruptions.
6. The challenge that regular events pose concerns the trade-off between the costs and benefits of investing in mitigation systems, while knowing that an event may not occur for generations (Alexander 2002; Winter 2004).
7. The intellectual movement, based at Carnegie Mellon University between the 1950s and 1960s, was led by Herbert Simon, James March, and Richard Cyert, and developed by William Starbuck and Oliver Williamson. See (Augier et al. 2005), and Gavetti et al. (2007).
8. Note that adaptation may also occur in other forms such as deploying existing routines appropriately. For example, when the number of fire trucks is adjusted to match the size of the fire (Miner et al. 2001).

9. Bricolage has also been associated to sensemaking (Weick 1993, 1998), entrepreneurial venture creation (Phillips and Tracey 2007; Baker and Nelson 2005; Garud and Karnøe 2003, Baker et al. 2003), and technology appropriation (Ciborra 1992), and it has been founded as an autonomous research topic (Hadida and Tarvainen 2014; Duymedjian and Rüling 2010; Cunha 2005a, b).
10. M. O'Donnell, "New Terrorism Response Plan Angers Fire Dept.," *The New York Times*, April 22, 2005, http://www.nytimes.com/2005/04/22/nyregion/22response.html?pagewanted=print&position=&_r=0, accessed 12 December 2014.
11. Note that, in some instances, these imaginative tasks are also referred to as "counterfactuals." However, counterfactuals only refer to the opposite situations of the ones that are being considered. Conversely, imagined cases generally include counterfactuals, but they more broadly include spurious cases.

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6

White Novelties and Their Capture

6.1 Overview

This chapter addresses the positive novelties associated with invention, discovery, innovation and creativity. Some examples include: magnetic resonance imaging (MRI), which was a breakthrough technology that enhanced the advancement of medical diagnosis and treatment; mobile phones, which have made the world more connected and reachable; and Zumba, which is a dance fitness program (with a specific trademark) practiced by approximately 15 million people worldwide. Such novelties are generally seen as having a positive impact on the broader human/welfare system. Thus, the attitude towards these types of novelties is not to avoid them, but to search for, foster and produce them.

However, novelty might also have negative implications at various levels; for example, MRI overshadowed other technologies adopted for medical diagnoses and burnt all investments in alternative technologies. Moreover, many novelties end up as failures; for example, Leonardo da Vinci's innovative technique of oil painting on plaster adopted for *The Last Supper* ultimately created difficult preservation conditions and resulted in a shorter life than the traditional fresco style. Nevertheless,

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the general attitude towards these cases does not change, nor does it change the emphasis on, novelty's potential success.

Traditionally, within the discourse on innovation, scholars have distinguished creativity as the locus for the production of novel ideas and innovation (Amabile 1988). Within innovation studies, the stage in which novel ideas are generated has been considered the "fuzzy stage" for it is "highly informal, knowledge-intensive and erratic" (van den Ende et al. 2015, p. 482). This stage is associated with outcomes that have mainly been understood as highly uncertain, while their nature is more challenging for both theory and practice since their determinants are ill-defined and not probabilistically defined (Frigotto and Rossi 2015).

In order to explain how ideas become innovations, scholars have conceptualised an evolutionary process consisting of a typical articulation: variation, selection and retention (Campbell 1960; Nelson and Winter 1982; Aldrich and Ruef 2006; Simonton 1999; Durand 2006). Such conceptual articulation can be recognised at two different levels: (1) in the process from the idea to the innovation as a whole, which consists of three stages (i.e., invention, development and implementation); and (2) in each of these three stages. As such, novelty, in terms of a new element introduced into the variation set, is mainly exclusive of invention in the first level, but it might spread among the development and implementation in the second level. Thus, novelty concerns all three stages of the invention-innovation process (Table 6.1).

Table 6.1 Novelty at different levels in the invention-innovation process

Macro-Level		Micro-Level
Articulation of the evolutionary process	Stages of the invention-innovation process	Elements within the stages of the invention-innovation process
Variation	Invention	Variation-selection-retention
Selection	Development	Variation-selection-retention
Retention	Implementation	Variation-selection-retention

Research on innovation originally focused on various aspects of technological innovation (e.g., Handerson and Clark 1990; Utterback 1994), while subsequent studies examined other forms of innovation such as process innovation (Pisano 1996), service innovation (Gallouj and Weinstein 1997), strategic innovation (Hamel 1998) and management innovation (Birkinshaw et al. 2008). The interest on the generation of ideas has mirrored the evolution of research on innovation. Moreover, various levels of analyses have been assumed, based on the individual, the organization and the system.

Organizations have focused on the approaches, tools and methods that could support variation, with the idea that such approaches, tools and methods could generate variations more likely to pass the selection screening because they have been "nurtured" for this purpose. The traditional perspective typically (though not always) assumes that the internal or internally controlled generation of ideas is the main way of approaching the innovation process (Chesbrough 2006). In fact, organizations' attempt to control the complex process of the generation of variation, with the aim of increasing the general success of the innovation process, has often had detrimental consequences, producing embarrassment for practitioners and posing further challenges for scholars. Consider, for instance, Kenneth Olsen's 1977 vision regarding the success of personal computers (see Frigotto and Rossi 2015, for references on this case). Kenneth Olsen was the co-founder of Digital Equipment Corporation. He predicted that personal computers would have been a sound failure in consumer market.

Recently, the generation of new ideas has gained increasing attention (e.g., Von Hippel and Von Krogh 2016), and it was brought back to the main focus of innovation studies as the "front-end of innovation" (Ende et al. 2015). Two main elements might account for such an outcome. First, the availability of information technology (IT) tools, which allow individuals to reach a large number of potential idea generators and collect their ideas at a low cost, shifted the focus towards the increasing costs of selecting generated ideas. Second, the increasing specialisation of scientific, technological and user knowledge made it evident that the main problem of organizations was not only the actual search for a

solution but also the decreasing control of the necessary knowledge to assess and select ideas.

Organizations' loss of control over innovation sources has increased as the diffusion of open innovation search processes has become more widespread, resulting in the engagement of diverse sets of people with specific expertise (e.g., "the users", "the crowd", "the experts"). In this regard, the phenomena of democratised innovation[1] (von Hippel 2005), distributed innovation[2] (Lakhani and Panetta 2007), open innovation[3] (Chesbrough 2006), broadcasting[4] (Jeppesen and Lakhani 2010), and crowdsourcing[5] (Estellés-Arolas and González-Ladrón-de-Guevara 2012; Nickerson et al. 2016), can be clustered within this trend. Deep specializations in knowledge domains and single areas of research imply that innovation can emerge from those who do not share the knowledge domain in which the innovation is ultimately adopted. As a consequence, when companies pursue innovation for their products, they typically search for it in the wrong area of knowledge because they are looking within their own knowledge domains. This consideration poses a clear paradox that will be addressed in this chapter: How can an organization control (i.e., design) the generation of novelty (i.e., variation) when novelty is more likely to emerge—or is more promising—when it belongs to a knowledge domain that is unknown?

This chapter is organized as follows. First, it positions positive novelties among invention, discovery, innovation and creativity. Second, it claims that such novelties appear in the entire invention-innovation process, and that such pervasiveness decreases the distinction of the various stages of the process. Third, it illustrates the process of novelty formation through a review of selected theoretical and empirical papers that highlight the main issues in the dynamics of novelty. Through this review, it searches for the basis of the dynamics of novelty and the dimensions that can explain its formation and success. Fourth, it revises the classical triggers of novelty through a different approach; that is, the garbage can model. Fifth, it focuses on cases of serendipity and discusses what triggers such cases. Through this focus on triggers, it discusses the possibility and limits of actively searching and controlling the appearance of novelty in organizations. Finally, it extends the latter discussion

to open innovation and provides a conceptual interpretation of its function by highlighting the critical elements.

6.2 Novelty in Innovation, Invention, Discovery, and Creativity

Probably the most prominent sibling concept of novelty is innovation. Over the past century, innovation has been considered the core of progress and success by both organizations and societies. Within academic research on growth and change, several studies have been conducted on various aspects of innovation. Primarily, innovation has been addressed in terms of technological innovation (e.g., Henderson and Clark 1990; Abernathy and Utterback 1978), where technology is reflected in economic models and changes in production functions (Ruttan 1959). Over the last two decades, the meaning of innovation has been extended towards other forms of innovation concerning how technologies are managed and organized (Birkinshaw et al. 2008; Volberda et al. 2014); that is, new processes (Pisano 1996), new practices (Canato et al. 2013; Ansari et al. 2014), new structures (Riccaboni and Moliterni 2009) and new strategies (Markides 1997). In this line, the concept of management innovation has been shaped to address management practices, processes, structures and techniques (activities) that are "new to the state of the art" and are meant "to further organizational goals" (Birkinshaw et al. 2008, p. 825; Volberda et al. 2014). This book appraises the role of management activities that remained in the background of technological innovation studies. Furthermore, innovation is also examined to address the changes in the "cognitive, normative or regulative mainstays of an organizational field" under the concept of institutional innovation (Raffaelli and Glynn 2015, p. 283).

In economics and in organization studies, the centrality of the innovation concept has grown as Schumpeter's theory has become more widespread. As some authors have indicated (Dosi 1988; Freeman and Soete 2004), such centrality arose in the 1980s and 1990s when the main factor of growth was attributed to technological change, rather

than to the increase in the volume of traditional inputs such as capital and labour (Freeman and Soete 2004, p. 3). By concentrating on innovation, Schumpeter's contribution defined a new, exclusive area of investigation that concerned the implementation, the usefulness and the benefits that could be obtained from an invention (Freeman and Soete 2004).

Although innovations might derive from *inventions*, Schumpeter clarified that innovation does not imply or require invention. In fact, invention is not necessary for innovation, which also occurs by providing a previously known product or practice to a new market. In order to stress the commercial-usability character of innovation, Schumpeter related innovation to the first commercial transaction of a novel product, process, system or device within a market. There was no concern regarding how the invention was generated. Thus, the invention "was provided" to the entrepreneur or the firm as an exogenous variable.

Economists welcomed this framework. For example, Ruttan (1959) stated that invention had rarely been addressed in economics due to the difficulty of providing a generally acceptable, analytical definition of the term. In economics, this focus downgraded the role of invention in the research on innovation. Conversely, in the sociology, history and scientific literature, the concept of invention has become more central and it has attracted more research.

However, in economics and organization studies, while not consistently or robustly addressed, there have been several attempts to better understand invention as representing an important (or potential) source of innovation. In general, the definition of invention was restricted to the generation of ideas for an innovation (Howells 2005). In fact, in Schumpeter's opinion, invention includes the "idea, a sketch or model for a new or improved device, product, process or system" (Freeman and Soete 2004, p. 6). The Schumpeterian idea of invention mainly implies technological inventions; he considered the patentable nature of most inventions (Freeman and Soete 2004). By investigating the conditions for patenting novel work or artefacts, this literature has opened the discussion on what inventions can be described and protected. These considerations have promoted a perspective on novelty that is less attentive to new practices, processes and other non-technological aspects of

products or systems that are hardly patentable. However, notable exceptions exist. For example, Arrow (1962) meant invention for the production of knowledge and information, which does not necessarily provide a technology.

Martin (2016) gave an interesting basis for this biased view of invention and innovation, and contrasted it with the present manifestations of innovation. Building on imprinting theory, according to which values, norms, ways of thinking, and acting, all of which have characterised institutions' experiences and have become embedded and taken-for-granted (Stinchcombe, 1965), he claimed that scholars conceptualise innovation in a way that reflects the dominant forms of innovation that existed 50 years earlier, when innovation studies were first introduced. As a result, innovation studies are more centred on technological and patentable innovation than on the present composition of innovations. In fact, such a view of innovation neglects innovative activity that is incremental, it does not take the form of manufactured product innovations, it involves little or no formal R&D, it does not typically occur in large companies, and it is not patented. As a reaction to this focus, some authors have drawn attention to what they have called "dark innovation" (Martin 2016) and "hidden innovation" (NESTA 2007); that is, the innovation that is not captured by present measures of innovation and by the traditional concept of innovation. For example, when new business models, organizational forms or institutional innovations occur in sectors that are considered low innovation providers, such as the creative industries, more incremental innovation occurs and provides (better) solutions to social problems, as seen in charter schools in the United States and the Tagesmutter in the German-speaking culture.

Other concepts related to innovation have played a similar role as invention. Machlup (1958, p. 18) contrasted invention to *discovery* as "an invention is a new contrivance, device, or technical art newly created, in contrast to a discovery of a principle or law of nature that has already "existed" though unknown to man". Subsequently, epistemologies have assumed that such dualism loses power if one considers that scientific discoveries are also, in nature, inventions of scientists' minds that interpret and give sense to their observations[6] (Piscopo and Birattari

2013). However, in some streams that display a strong realistic ontology, discoveries are meant to address scientific achievements, which concern the laws of nature, while inventions concern artefact and technologies.

More neutrally, from the epistemological point of view, *creativity* has been related to the generation of innovation. Creativity was first defined in relation with products that are original, useful or valuable (Barron 1955). Stein (1974) then defined creativity as a process that generated "novel work that is accepted as useful by a significant group of people at some point in time". As reviewed by Amabile (1986), the plethora of definitions of creativity stresses its multi-faceted nature. The latter is also reflected in diverse focuses on the creative processes, products, persons and contexts (Vehar 2013). However, in contrast with innovation, creativity (like invention) is the starting point (Amabile 1986), and it concerns the production of an idea, while innovation brings the idea to life (Vehar 2013).

According to recent and earlier reviews (e.g., Vehar 2013; Ruttan 1959), the concepts of invention, discovery and creativity have largely been used as synonyms with no particular attention on their peculiarity. They are often interchanged or can be substituted for one or the other with no meaningful impact on the overall meaning of innovation (e.g., Vehar 2013). The preferences for such terms generally reflect a disciplinary inclination such as creativity for the fields of art and psychology, and discovery for the areas of science and technology. When both creativity and discovery are addressed within organization studies, such inclination is still maintained. For example, although creativity is also present in technological research, studies on creativity typically concern non-technological aspects of products and processes. Moeran (2013) mentioned creativity in porcelain products at Royal Copenhagen, Cattani and Ferriani (2008) addressed creativity in the Hollywood film industry, Krause-Jensen (2013) studied creativity in terms of design at Bang & Olufsen, while Barrett (1988) studied creativity in music. In the same line, a broad stream of literature studying patents (e.g., Benner and Tushman 2002) typically focused on technological inventions. However, within the literature on innovation, there are widespread discussions regarding the distinction between the different stages of the invention-innovation process; that is, creativity concerns the production of novel ideas, while innovation is the successful implementation of novel ideas (Amabile 1988).

Table 6.2 Invention, discovery, creativity: distinctions and adoption habits

Innovation Studies	Sociology, History, Science and Technology Studies	Psychology
invention is used to talk about the generation of technological ideas or artifacts	invention is used to talk about the generation of ideas or artifacts with no distinction between technological or non-technological nature	creativity is mainly used to talk about the generation of all forms of novelty
discovery is used to talk about the identification of new laws of nature		
creativity is used to talk about the generation of non-technological ideas	discovery is used as in Innovation Studies	

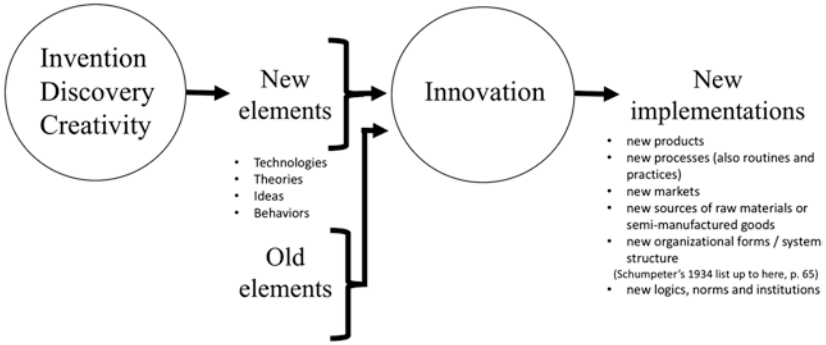


Fig. 6.1 Sources and manifestations of positive novelty

Despite different disciplinary preferences and semantic focus (see Table 6.2 for a synthesis), invention, discovery and creativity populate the set of potential sources of innovation, and they concern novelty in various ways. In fact, there is no agreement on the broad theory of innovation. However, it is agreed that innovation "involves newness" (Dunlap-Hinkler et al. 2010, p. 106), and novelty is the concept that implicitly aggregates the various sources of innovation; that is, invention, discovery and creation, in addition to innovation itself (Fig. 6.1).

The focus on novelty clusters all of these manifestations and directs attention on the common underlying mechanisms of its generation and development, rather than its non-core properties.

6.3 Novelty Along the Innovation Process

Discussing novelty in the various forms of creativity, invention and discovery might infer that it only occurs in the first stage of the innovation process. However, as Table 6.1 showed, novelty does not appear once and for all, but appears in various ways in the development and implementation stages. More broadly, the concept of emergent strategy (Mintzberg 1978; Mintzberg and Waters 1985), captured at the firm level and in the realm of strategy, represents the developmental nature of novelty deriving from new opportunities as well as from the further clarification of ideas and plans that occurs through implementation.[7] The point here is that once it has been introduced, novelty requires elaboration and acceptance. Furthermore, non-novel elements can acquire novelty along with new elaborations or new acceptances in terms of new appearances, new uses, and new meanings. Therefore, the development and the implementation stages are, per se, loci where novelty occurs, and in this sense, they host variations in a similar manner to that in the early invention stage (Table 6.1). Implicitly, this sequence of stages assumes that emerging novelty displays a different gradient of novelty; that is, the higher it is at the start, the greater the decline in the later stages. However, this assumption is also misleading, since it places more attention on the invention stage and it diminishes novelty occurring in the other stages. While it might appear logically consistent that the birth of something that did not exist before displays more novelty than its development, a closer and more accurate look at the phenomenon allows one to understand that the link between what is novel with what existed before is more complex than straightforward. In addition, it does not provide a *definition* or a set of *dimensions* to account for and understand novelty. Compare the following extreme cases. On the one side, consider the novelty provided by the Narayana Health in India, which combined quality health services with low prices in a territory where the healthcare supply per inhabitant was extremely low. On the other side, consider the

Table 6.3 Key mechanisms of novelty formation

Stages of the invention-innovation process	Key mechanisms of novelty formation
Invention	Recombination
Development	Transformation
Implementation	Institutionalization

novelty displayed in a new game for one of the gaming platforms. In sum, the first consists of a service that is not new (since hospitals exist elsewhere), but is new in terms of its business model and the context in which it occurs. The second is new (since it did not previously exist), but it is inserted into a solid business model and an established market.

Finally, novelty appears as the outcome of key mechanisms typically occurring along the three stages of innovation production (i.e., invention, development and implementation). These key mechanisms are, respectively (Table 6.3): *recombination*, *transformation*, and *institutionalization* (Garud et al. 2013). Through our review of the contributions on such mechanisms, we search for the dimensions along which novelty can be understood and for the dynamics along which the occurrence of novelty in organizations can be explained.

6.3.1 Recombination: Novelty Across Old and New

The extant literature acknowledges the origins of novelty in terms of the recombination of existing elements. Schumpeter himself attempted to understand the origin of such novelty, which he called "development". He believed that novelty was responsible for significant shifts in different cost curves, equilibrium points and cultural norms. He explained the origin of novelty through the biological metaphor of mutation. However, he considered mutation a non-explanation, as its dynamics was largely unknown. Therefore, he focused on less disruptive novelty: novelty that is the result of recombination (Becker et al. 2006).

Recombination is currently the main explanation for the occurrence of novelty. While novelty deriving from recombination can be disruptive, unexpected or "out-of-the-blue" novelty is disruptive by definition because it comes from a knowledge domain or through a set of dynamics that are not conventional.

Recombination refers to the original assembly (Garud et al. 2013) of two aspects in particular: (1): content elements among themselves, which include ideas, artefacts, routines practices; for example, the smartphone is a combination of a mobile phone with the camera, an iPod, a web browser and a (limited) computer; and (2) content elements and different functions that originate from other purposes; for example, the ski pass adopts the technology developed for rapidly paying tolls on highways, the hair cream for esthetic wax was originally invented for plucking chickens in the poultry industry,[8] and microwaves were originally adopted for communication purposes, but are also used for radars and microwave ovens. Recombination also concerns ideas, artistic creations, organizational forms and cultural norms.

Adopting a strategic approach, Durand and Khaire (2016) identified two types of recombinations.

The first type produces a *reshaping* of the field and that redistributes competitive appeal and power of players in the market. Novelty from reshaping occurs through a rearrangement or reinterpretation of existing cognition, as it happened, for example, within the introduction of the "grass-fed" or "organic" category in meat production (Weber et al. 2008). The second type of recombination is associated to the need to find a name or identity to *new* things that did not previously exist and that the existing classification system does not sufficiently consider.[9] Among the examples given by the authors, there is the smartphone and the minivan, both of which derive from the combination of features previously provided by different products. The distinction between these two types falls between something that existed earlier (the smartphone is an evolution of the phone) and something that did not previously exist and has been given a new name and an identity (the minivan is a new concept of car).

These two types of recombinations are interesting since they articulate novelty. However, their distinctive definitions seem to be somewhat blurred.[10] More specifically, one could argue that it is not straightforward to distinguish what previously existed from what did not exist, since the recombined elements actually existed earlier. For example, one could argue that despite the fact that organic food has always existed, the new category of "organic" suggests a healthy lifestyle that did not

previously exist. In addition, one could argue that, despite the fact that minivan did not exist before, they display features of both station wagons and vans, with which people are familiar.

A further element that Durand and Khaire (2016) added to characterise the two types of novelty (from a strategic perspective) is the *impact* that novelty provides on the structure and composition of the supply side. For novelty from reshaping (first type), the industry is mostly populated with the same actors and the existing order is maintained, with the exception that the value captured is to the benefit of the new category's promoters. For newly existing novelties (second type), new market actors, organizations, products and intra-field changes in leadership occur. However, while the impact is an interesting dimension to assess novelty, there are several communities on which novelty might have an impact and it would be necessary to specify the reference system against which novelty is assessed. As a matter of fact, novelty in the form of social innovations has an impact on society, since society can greatly benefit from them. For instance, working conditions, education and healthcare improve overall social conditions. However, the structure of the supply might not be upheaved.[11] Microcredit is a good example of novelty with a significant impact on society, which has not disrupted the previous financial system but has developed it in countries where it was previously lacking. As such, this novelty is not disruptive, but it is mainly complementing the present actors in the field.

As second contribution to the understanding of novelty in terms of recombination, Padgett and Powell (2012) also distinguished two different types of novelty, according to their impact on the systems in which they appear. In doing so, they also suggested some robust dimensions in order to understand novelty. *Novelty one*[12] has an impact since it improves *existing ways* of doing things. *Novelty one* is imported to the target domain from adjacent domains, and it derives from the combination of practices, concepts and ideas that sound familiar enough within the target domain due to the proximity of the target and the adjacent social community. *Novelty two* has a great impact and it is closer to "genuine novelty" (Padgett and Powell 2012, p. 1), since it provides *new ways* of doing things. *Novelty two* is transposed from distant domains,

and it derives from practices, concepts and ideas that sound highly unfamiliar in the target social community.

Although Padgett and Powell were never explicit about it, in this author's interpretation, it is implied that their "domain" is the domain of knowledge and meaning, which is mirrored in a social community. As such, novelties derive from permutations of the semantic and social contexts (i.e., the semantic and social origin context, and the semantic and social target context). Building on Padgett and Powell (2012), it is possible to state that, whether novelty approaches "genuine novelty" or it is incremental and closer to the former version depends on how it reverberates by altering its semantic and social contexts. Although *Novelty one* and *Novelty two* are both based on recombination, the latter might appear to the target community as something unexpected, since the combinatorial material is unknown or unfamiliar to them. Thanks to Padgett and Powell we can seize what differentiated Durand and Khaire's (2016) recombination types.

The literature has examined the position of the people in their social contexts as a way to explain who constructs the recombinations and why they are constructed. At the individual level, recombinations are provided by those who bring together elements or those who do not belong to the same community. We refer to the community where novelty is produced as the *target community*. The most creative actors are bridges between loosely connected communities; that is, they solve the so-called "small world" problem typical of highly connected communities. This "small world" problem derives from the fact that community participants generally develop stable, routine interactions based on common interests or patterns of behaviour. This means that typical community actors relate very little with actors who do not belong to their community, and, as a consequence, they are rarely exposed to interests, ideas or initiatives that do not originate within the community. In addition, in a highly connected community, members are very similar. By acting as bridges, therefore, creative actors link communities that are highly connected and specialised by developing languages and problems that sound interesting and challenging to more than one community. In so doing, they have a greater potential to produce novelty,

since they are familiar with more ways of thinking, selecting, synthesizing (Burt 2004) and recombining. Creative actors are typically positioned at the peripheries of the communities they connect; thus, they are not completely absorbed by any one community's logic or behaviour (Greenwood and Suddaby 2006). This argument leverages diversity, which has been acknowledged to support novelty and higher performance, at least under certain conditions (Hong and Page 2001, 2004; Page 2007; Frigotto and Rossi 2012).

On a completely different level of analysis, recent research on routines has focused on the issue of novelty. Routine has been defined as "a repetitive, recognizable pattern of interdependent actions, involving multiple actors" (Feldman and Pentland 2003, p. 96). Research on novelty in routines expands the discourse by focusing on novelty in actions, and more precisely, on novelty that does not remain accidental but that becomes part of and stabilised into a repeated behaviour. Routine dynamics has been theorised as a recursive relation between the ostensive and the performative aspects of routines (Feldman and Pentland 2003). The ostensive aspect consists of the conceptualised pattern of a routine, as it has been formed through the enactment of the routine by actors over time, while the performative aspect consists of the actual enactment of the routine by actors in a certain time and space. Through their enactment and reflection (Jordan et al. 2009), routines are modified and novelty appears.

This research has mainly been concerned with *unintended novelty* in routines, in an attempt to answer the question on how routines can be recognised among variability, which is inevitable and characteristic of the different enactments of the routine each time it is recalled (Rerup and Feldman 2011). Conversely, a recent study by Deken et al. (2016) focused on how novelty is produced *intentionally* in routines, with the purpose of reaching deliberate performance outcomes. They identified three ways of producing novelty: (1) *Flexing work*, which refers to *adapting* existing routines in order to match novel intended outcomes (in this case, change is so that routines are still recognisable to the actors involved); (2) *Stretching work*, which refers to finding *novel usages* of existing routines (in this case, change occurs in the entire range of the routine and in the involvement of actors who are familiar/unfamiliar

with the routine); and (3) *Inventing work*, which refers to creating *new routines* as new ways of realising intended outcomes (in this case, change occurs in routines that are recognised as different from the existing routines by the actors involved).

Interestingly enough to this discourse, when several actors with diverse experience/familiarity with the routine deal with it, several novelty understandings appear. Feldmand and Rafaeli (2002) found that actors draw on such diverse understandings to evaluate the novelty produced, and that such diverse approaches anchored in the diverse, experienced routines increase the potential for the breakdown/failure of the novelty generation process. This also explains why some actors do not see the novelty or attempt to respond to it through flexing work, while others envision inventing the work from the outset. Reversing the consideration, whether actors engage and are more likely to succeed with novelty generation in routine work "depends on the emergence of shared understanding between specific actors in a specific situation about what is appropriate" for pursuing novel intended outcomes (Deken et al. 2016, p. 674). The more diverse the actors, the more difficult it is to build this shared understanding. Finally, this novelty generation is not an "on-off" event. Instead, it consists of an iterative recursive process, which is reduced when the actors' understanding includes the anticipation of the consequences of novelty.

By analyzing, flexing, stretching and inventing work, what this book suggests is that, when the challenge embedded in the task increases and intended novelty to be produced is prominent (especially in inventing), existing routines provide the materials for recombination. However, they are not combined as "ready-to use" parts, but as understandings on the functions, deployment patterns and production implications of these parts, which are based on previous use and experience. In this perspective, the routine part that is combined is less traceable in the final outcome, thus posing the question on the relationship between novelty and "oldness". Moreover, the level of analysis in which novelty should be examined and defined is not the level of the artefacts themselves, but at the level of the idiosyncratic understandings belonging to the diverse actors involved.

6.3.2 Transformation: Core Rigidities, Blindness, Divergent Thinking

Transformation refers to the fact that ideas are heavily revised before they can come to fruition.

Two main approaches to transformation have been acknowledged in the literature: breakthrough and bricolage (Garud and Karnøe 2003). They build on the consideration that the development of novelty involves the efforts of a multiplicity of actors who provide complementary assets, usage feedback or institutional norms and spaces to discuss them. Breakthrough starts with the aim of producing a breakthrough novelty. This approach is intuitively considered as better for leading to disruptive change, at least compared to bricolage, which starts with local improvements and progressively scales to more distant improvements. However, breakthrough is extremely risky, since it requires the involvement of the multiplicity of actors, which are necessary for the development of novelty. Conversely, bricolage is a process that leverages actors' local knowledge as a starting point, where gradual transformation to more distant knowledge is triggered by the interaction between relevant actors and knowledge through common and mostly shared learning paths. Through bricolage, designers, users, policymakers, and others engage in co-shaping and providing a diversity of linkages to foster the mutual involvement of actors, which will most likely prepare the acceptance of the initiative. Eventually, bricolage is "particularly valuable in situations characterised by complex non-linear dynamics among the actors, artifacts, and rules that constitute a technological path" (Garud and Karnøe 2003, p. 296).

However, transformation does not always take place and novelty does not always appear in this phase, even if, from an ex-post perspective, it could have been expected. Several cases can be cited from organizational literature, and many more belong to everyday experiences that have not found any popularity. For instance, Polaroid did not transform its business from analogic to digital photography (Tripsas and Gavetti 2000).

The literature has delineated several reasons why transformation does not occur within firms. One reason can be seen in existing core

competencies that become "core rigidities" (Leonard-Barton 1992) which hamper transformation. Such core rigidities might have a technological (but also non-technological) nature, such as those concerning complementary assets that are necessary to commercially develop the innovation. They also might be due to the upper echelons' understanding of the world that orientate and direct learning as well as influence the evolution of organizational capabilities, which did not support the transformation in the Polaroid case (Tripsas and Gavetti 2000). Similarly, the well-known case of Intel (Burgelman 1991, 1994), showed the upper echelons selecting/nurturing the novelty initiatives. However, the survival of Intel was related to the novelty cultivated through autonomous "bottom-up" processes that escaped the firm's internal selection.

More recently, Almandoz and Tilcsik (2016) pointed out that when uncertainty is high and the members of a corporate board are experts in the industry in which the company's business is done, decision making is typically not effective, and transformation is likely not to take place. The authors explain this result in this way. First, there is a general overestimation of the accuracy of judgements performed by the experts in the board; second, there is the so-called "cognitive entrenchment"; that is, in a specific domain experts are bounded by the generally adopted mental schema (Dane 2010). For example, expert bankers that run models and numbers tend to ask the same questions; for example, "What is your debt to income?" Then, they leverage on their experience by stating "With this [previous] bank, we did it this way" or "What could happen is that, I am a banker, and if I have given loans to [a certain type of borrower] in the past, I am going to tend to give loans to [those borrowers] again" (Almandoz and Tilcsik 2016, p. 1127). The problem, in this case, is that someone, not sharing such expertise and looking at the case with "fresh eyes", would gather different information, make different considerations and take different decisions.

As a final point, recent research has shown that part of the problem is based on the fact that the decision to transform an idea in

organizations and industries is entrusted to the wrong people. In addition, the typical roles designed in the novelty generation process are inefficient for maximising the likelihood of producing the best novelty. Invention and development are entrusted to different divisions within the same firm or different organizations in which a clear division of labour exists; that is, one area provides the idea, while the other evaluates the idea. Berg (2016) built this claim according to a study of the circus industry, where artists' present their new acts at auditions, after which managers decide what new acts to put on stage. In this context, managers decide if the created ideas should be developed and presented in the market. However, this study showed that the idea creators were more accurate than the managers when forecasting others' novel ideas. Conversely, they lost their advantage over managers when they were forecasting their own ideas. The results, based on a paired lab experiment, showed that the creators' advantage over the managers in predicting success may be explained by the creators' emphasis on both divergent thinking (which is typical of idea generation) and convergent thinking (which is typical of idea evaluation), while managers only emphasise convergent thinking. Divergent thinking involves searching for new idea associations, combinations or perspectives to frame ideas, while convergent thinking involves applying criteria, standards, schemas and logics developed within individual or shared experiences. According to theories on cognition, novelty is more efficiently selected and supported when divergent thinking and convergent thinking are linked and iteratively adopted, rather than when they are separated, both temporally and in roles.

To complicate the picture further, as already mentioned when introducing breakthrough and bricolage, novelty arising through transformation typically involves several organizations that mobilise resources/competencies for the development of the idea and innovate each interdependent component of the novelty. The concept of technological platforms captures this dynamic (Gawer 2014). As a result, the supporting (or hampering) elements and processes described above are played out across several organizations.

6.3.3 Institutionalization: Novelty Through Contagion, Translation, Transposition, Robust Action and Design

Institutionalization refers to the fact that, when the potential and viability of an idea has been demonstrated, it does not mean that its benefits will be exploited. Widespread implementation requires diffusion, which is typically represented through contagion models (Garud et al. 2013). Diffusion implies reinvention, since adopters change the innovation in order to adopt to their context and circumstances (Rogers 1983). Regarding novelty in terms of artefacts, technological platforms provide contagion since they are the means through which standards are diffused and their large adoption is supported. For example, Android and iTunes platforms offer app developers a basis on which they can build their inventions. Moreover, while creating new apps, developers might change the interfaces of the platform, thus producing novelty in the platform. Google and Apple have a very different perspectives regarding how novelty can be created; that is, Android is essentially an open platform (meaning that developers can change its architecture while they build upon it), while iTunes is a closed platform (meaning that change is not emergent, but controlled from Apple). Recently, Google decided to introduce measures to control its operating system and its evolution (Yoo et al. 2012). Based on the above, transformation concerns various ideas, business models, organizational forms, categories and cultural norms.

While contagion is the closer modality to the biological metaphor, it is not the only modality for transformation and for novelty to occur in this stage. Moreover, it does not adequately convey that actors play an active role in managing adoption. The actor-network theory (ANT) on this point claims that diffusion occurs through "translation", a mechanism through which actors involve and entangle other actors with novelty. Translation has been articulated in four aspects: *problematization*, *interessement*, *enrollment*, and *mobilization* (Callon 1986; Latour 1987). *Problematization* consists in a framing activity where the elements are defined; that is, the problem, the knowledge claim, and the actors are required. A prominent role is acknowledged to the primary actor who

typically raises the problem and draws it as a necessary and unavoidable point (called the "obligatory passage point" (OPP)). *Interessement* refers to the actual identification and involvement of actors who negotiate their role and identity. *Enrollment* is the acceptance and stabilization of such roles and identities, while *mobilization* concerns the acceptance and support by actors who are external to the original network and who do not participate in its initial development. Callon (1986) originally illustrated this process with reference to the institutionalization of the framework, according to which the decline of the scallop population in St. Brieuc Bay was due to specific reasons.

Similarly, translation can be recognised as the process through which management ideas become management fashions (Abrahamson 1996). Management fashion setters—consultants, business schools—define an OPP in terms of the most efficient and effective technique within the socially shared ideology of managerial progress. Since managers feel the urgency to adopt them, more consultants suggest their adoption, after which business schools teach them and management students learn them. As a result, all of these actors assume a clear identity and role in the propagation of the management technique. In addition, when there is an unsolved problem for a certain technique, a management technique (framed as solving the problem) will have quicker propagation. This case also makes evident that the managerial technique (which is "in fashion") is not necessarily the best technique for the problem. In addition, its persistence will depend on the time another management fashion technique takes to sound more attractive than the available technique and established as the new fashion.

In a different field, the same dynamics can be seen in the case of rare diseases, as relevant problems for society, and in the development of research for such diseases (Frigotto and Riccaboni 2011). Pharmaceutical firms generally neglect rare diseases since the potential market is too small for obtaining sufficient returns on investments.[13] The case of Rett Syndrome[14] shows the prominent roles that the families of patients' associations played in establishing a direct connection and an OPP with scientists. First of all, they collected the contact information of patients with rare diseases, who were typically geographically dispersed. In this way, they showed the relevance of the

diseases among the total population. Relevance is also important for scientists, who typically feel more gratified when their work is useful to more people. Moreover, they provided scientists with data to conduct their research. Second, they raised money and directly funded the research on the diseases, and pushed towards clinical trials with a strong focus on finding cures for the diseases. Third, they drew public attention and grew awareness of the rare diseases, with the objective that more people will link to the network as supporters and/or patients. An interesting way in which the families of patients' associations revived and reinforced the link with scientists and the problematisation was through conferences, which included scientific sessions and patient–scientist sessions in which the scientists could explain their cutting-edge research and the patients' families could pose questions and make requests. In this exchange, scientists "translated" their outcomes for families and the families manifested their needs in terms of the research targets for scientists.

While the ANT attempted to draw a connection between the macro-level of the system and the micro-level of the individual, which is empirically traceable, neo-institutional scholars built an understanding of institutionalization, which lies in the dynamics at the system level and takes the form of the process by which extant organizational forms, cultural norms, categories or standards are diffused and institutionalised. At the organizational field level, novelty, as institutional change, occurs through jolts, deinstitutionalization and reinstitutionalization; that is, through a process in which a sudden "hit" triggers the de-freezing of existing organizational forms and eventually their re-freezing into new organizational forms (Greenwood et al. 2002). Padgett and Ansell (1993) theorised a process of transposition, refunctionality and catalysis across multiple social networks. In other words, this process is referred to the processual states of social networks as the main ingredients of change and of novelty, correspondingly. Transposition refers to the repositioning of social relations from one domain to another, so that they can gain a new functionality—new aims, new motivations, and new pursued outcomes (refunctionality). Catalysis refers to the reinforcement and reproduction of the two first steps through feedback.

More recently, a new line of work (despite raising a lively debate) focused on individual efforts to introduce novelty into the institutionalization phase.[15] When declined into the individual, change is embodied by "institutional entrepreneurs" that bring "institutional innovations" (DiMaggio 1988; Raffaelli and Glynn 2015). Among the prominent studies that have become a reference in this perspective, there is the analysis of Thomas Edison and the institutionalization of electric lightning in cities (Hargadon and Douglas 2001) or Cosimo de' Medici and the institutionalization of his power in Renaissance Florence (Padgett and Ansell 1993). These works show the role of what they call "robust design" and "robust action", respectively, by which the innovators managed to gain acceptance for their innovations.

Robust design refers to the design of a new technology, which not only "appear[s] novel to draw attention and suggest an advantage", but also displays meaning and value "in the language of existing institutions by giving them the appearance of familiar ideas" (Hargadon and Douglas 2001, p. 478). In other words, this study suggested that the success of the translation process also depends on an intrinsic property of the innovation; that is, how it appears and what complementary assets it relies on, as a "hidden value in the design of innovations, what might be called robust design" (Hargadon and Douglas 2001, p. 479). This reflects the peculiar time and space where the innovation is proposed, since it builds on the meanings and values that are embedded in the institutional environment in a specific place in time. For example, Thomas Edison designed the incandescent light around the features of the already familiar gas system; that is, he created his novelty based on preexisting understandings, and the values and uses of the technology by the public. However, he also designed it in a way that incandescent light could evolve beyond such limited understanding and use.

Robust action refers to actions that speak to diverse communities by carrying diverse meanings to those who interpret them. This property is called *multivocality*. Robust action represents an element through which diverse communities are related and combined, starting/leveraging from an existing context of multiple social networks and multiple meanings embedded in these networks. Cosimo de' Medici was able to connect

otherwise completely separate oligarchic families, and his actions made sense to the set of diverse actors. Through this connection, he gained power and set the dominion of the Medici family in Florence, Italy. Both cases point out, through their "robust" attributes, that design or action is related to and it speaks to several institutions; for example, concerning the way illumination was experienced in various cities in the nineteenth century or the way that power was gained and exercised in Renaissance Florence, regardless of what they exactly were or, as Hargadon and Douglas (2001) indicated, would become.

As another way to explain why the individual ideas of an innovator is welcomed and produced (or sometimes neglected), Johnson and Powell (2015) introduced the concept of *poisedness*[16] to account for the emergence of another new organizational form, as seen in the research-intensive botanical garden in nineteenth-century New York. *Poisedness* has been defined as "the availability or vulnerability of a social and historical context to the reception of an innovation and subsequent reconfiguration by it" (Padgett and Powell 2012, pp. 26–28). This concept is not limited to enabling conditions or opportunity structures (Stinchcombe 1965), but the "concatenation of social, political, and economic forces" (Johnson and Powell 2015, p. 1). Despite that this concatenation is illustrated through accurate historical accounts, it has yet to gain an analytical definition.

Explanations for the reasons why individuals succeed or fail in their institutional innovation projects have been related to biographical trajectories with relevant aspects, including sponsors or sources of knowledge (Burton et al. 2002), social skills that allow one to interact and persuade relevant actors (Battilana et al. 2009), and available organizational templates/resources that provide the infrastructure for acquiring new settlements, legitimacy and resources (Ruef 2000). The level of embeddedness in the community has also been pointed out as relevant. Often measured in terms of position in a social network, low embeddedness in a community makes individuals and organizations more open to organizations with new ideas and alternative possibilities. Novelty and change are likely to emerge from contestation over institutional legitimacy by actors who are positioned at the periphery of the

community. However, in institutions in which performance is valued, poor performance triggers the motivation to innovate, and when central actors produce novelty, it is more likely to gain adoption and eventually succeed (Greenwood and Suddaby 2006).

6.4 Triggers to White Novelty and the Issue of Agency

The previous section presented the mechanisms through which novelty occurs along the innovation process. However, it did not address the question of what triggers the appearance of novelty and, as an implication, the issue of agency.

In the realm of innovation, the motivation for novelty to occur has traditionally been found in two alternative triggers: the demand-pull and the technology- or science-push (Freeman 1974, 1979). The former points at solutions that are found since problems, formulated in terms of unsolved needs, have been posed by or inferred through customers' preferences and demographic characteristics, while the latter points at solutions (i.e., technologies, discoveries, ideas) that are found in the pursuit of scientific progress and research.[17]

In the demand-pull trigger model, despite that the solution has yet to be found or formulated, the framework between the problem posed by the market and the solution provided by science/technology is well defined, and the effort/challenge resides in actually finding a solution. In this case, the missing pieces of the puzzle have a well-identified spot in the overall picture. For example, the electric bicycle is a solution to the needs of local mobility, with limited effort and sportive preparation.

In the technology-push trigger, novelty, in the form of invention or discovery, appears within the framework of the *scientific/technological* problem-solution, where a scientific problem has been posed and a solution to that problem has been searched. Then, the solution developed within the scientific/technological field needs to find a match with a problem belonging to the market. Consider, for example, X-rays. Soon after its discovery, such technology was not only used in medicine but

was adopted in neo-occult sessions, artistic photography and even in shoe stores to see how the feet were positioned in shoes. In the market-pull situation, the greatest challenge is finding a good solution, but when a solution is found that responds to an existing problem, the meaning of novelty is immediately clear, and judgement focuses on the effectiveness/efficiency of the solution. In contrast, in the technology-push situation, the greatest challenge is finding a market problem that the technological solution can answer. In sum, the actual meaning of the solution is not straightforward, but it is found by finding its applicability. Furthermore, the judgement of the solution assesses if such construction is solid and persuasive.

6.4.1 A Reinterpretation Through the Garbage Can Model

A way of interpreting (or reinterpreting) these triggering forces and their critical issues is through the traditional problem-solving model and the framework offered by the garbage can model of organizational choice (Cohen et al. 1972; Fioretti and Lomi 2010). The traditional problem-solving model claims that problems and solutions are linked in a one-to-one relationship in which the problems have priority. In general, we tend to prefer the idea that a solution cannot be found before a problem has been formulated. However, in several cases, we do not understand what the problem is until a solution has been considered (von Hippel and von Krogh 2016). Problems have been defined as the concerns of some people, while solutions are the products of some people (Cohen et al. 1972). The original garbage can model focuses on the implications of effective problem solving and the claim that problems and solutions can be matched according to other rules than the logical link that bonds a question with its answer. The other implication of this claim, however, is that we often have solutions without problems, in addition to problems without solutions. Moreover, solutions might have been developed in relation to some problems, but then, their storage occurs independently from the problems. Problems are also stored

independently, after which their relationship is forgotten as other relationships with different problems are discovered. Fortunately, it is possible to identify this dynamics at the individual level, the group or community level, and the field level.

According to the language of Cohen et al. (1972), both in the demand-pull and the technology-push situations, we have "buckets of problems and solutions", and through their combination, further novelty (besides the novelty produced by originally formulating problems and generating solutions) is produced. The demand-pull situation deals with problems, typically posed within the market, and triggers the search for solutions for those problems, arising from the scientific/technological fields. This is the traditional question-and-answer relationship, which can also develop across fields. Conversely, in the technology-push situation, solutions, typically developed in relation to problems raised within the scientific/technological field, search for new problems, delineated within the market field. This is a counterintuitive relationship that goes from solutions to problems, which develops across fields.

"Buckets of problems and solutions" are unrelated to the solutions and problems that were originally attached to them, meaning that they are used independently. However, within the context in which they are raised, the association with the original solution or problem, respectively, is present and more persistent. In addition, the starting point is different for the two situations. In the demand-pull case, the journey begins with market problems that more traditionally search for solutions, while in the technology-push case, the journey starts with technological solutions that search for market problems.[18] In both cases, problems and solutions are searched for independently from the respective solution or problem, in relation to which they are generated (Fig. 6.2).

Two cases can be reported as examples in which novelty also derives from the link between independent problems and solutions (Fig. 6.3). First, the case of the invention of airbags can be positioned within the market-pull model. John Hetrick, an industrial engineer and member of the U.S. Navy, was moved by the desire to protect his family in the case of an automobile accident. As a result, he designed the airbag and

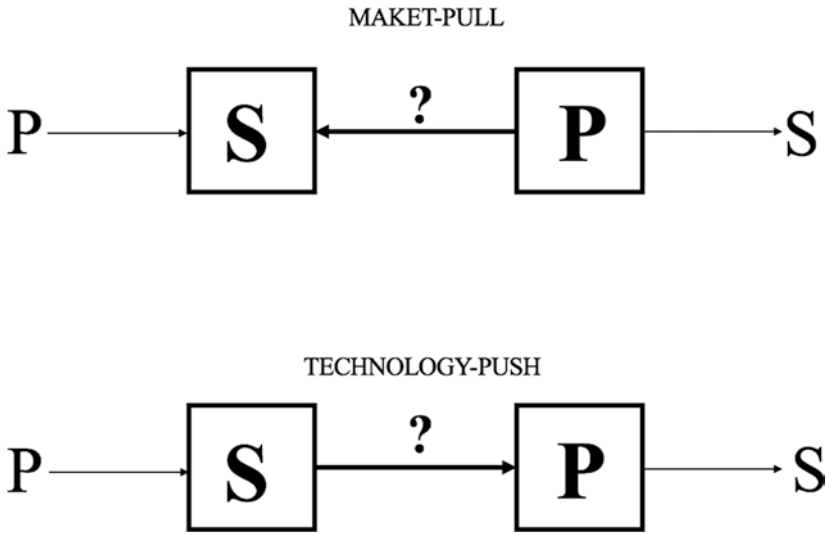


Fig. 6.2 Market-pull and technology-push models as connections of independent problems and solutions

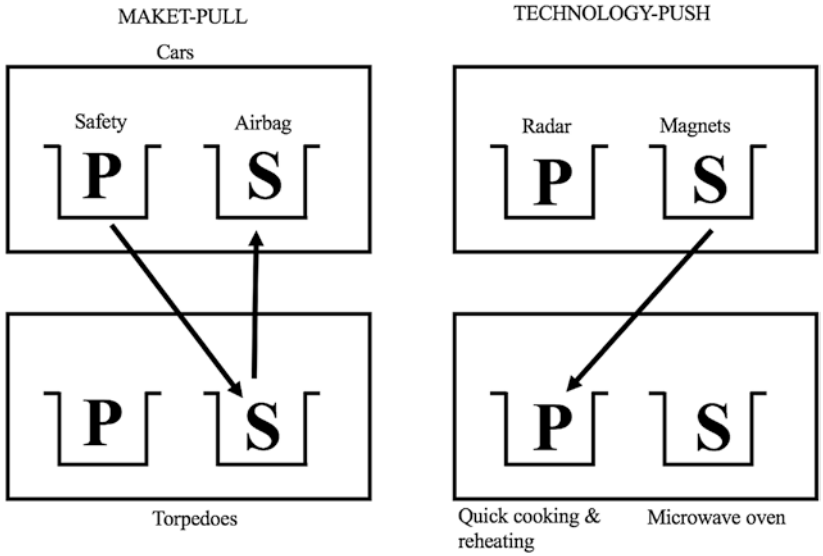


Fig. 6.3 The cases of the invention of the airbag and of the microwave

patented it in 1951, building on his experiences with compressed air from torpedoes. Second, the case of the invention of the microwave can be positioned with the technology-push model. In 1945, Percy Spencer was conducting research on a radar set and noticed that the candy bar he kept in his pocket melted. Thus, he started experimenting with microwaves by cooking popcorn.

6.4.2 Social Positions and Control in Novelty Emergence

In the behavioural theory of the firm, agents are cognitively limited, have limited time, information, and resources, and thus, they tend to restrict their searches to contexts that are more familiar and require lower costs (March and Simon 1958; Cyert and March 1963). In the garbage can model framework we adopted in the previous section, this is reflected mainly in the fact that agents search in buckets of problems and solutions that belong to domains of knowledge they understand well and about which they have the most information, typically because they are more recent. Thus, novelty, which derives from connections of problems and solutions stored in independent buckets, is limited to the combinations of domains that are more familiar and that have a lower potential to produce "genuine novelty", as suggested by Padgett and Powell (2012, p. 1; see the concept of novelty two in Sect. 6.3.1).

The implication is not only that agents typically do not search in distant knowledge domains, but also that when they face such domains, or when they consider some possible connection between the problems in their domain and solutions in distant domains,[19] they are often not ready to understand or assess the validity of these connections. Sometimes, they cannot even imagine such connections because of the limitations of their distant knowledge. In such situations, it is reasonable to expect that drawing connections between problems and solutions whose buckets do not belong to an agent's memory or domain of knowledge is challenging. Furthermore, given the myopic tendency of agents to cumulate knowledge in areas that are well known, rather than to explore unknown regions (Levinthal and March 1993), their ability to connect their problems to solutions[20] belonging to unfamiliar

knowledge domains is typically very remote and unlikely to rely on an individual agent's search skills or his ability to imagine what he has never known of.

Given the above considerations, the picture of the dynamics of the generation of novelty is complicated not only because of the separation of problem and solutions but also because of the fragmentation of knowledge domains within which problems and solutions arise and because of the capability of agents to dominate only one or very few domains. Note that, in the previous paragraphs, agents' behavioural tendency to prefer what is familiar has been described in terms of knowledge domain focalization. However, the knowledge domain refers not only to the technical knowledge typical of an expertise or a discipline (e.g., chemistry or modern architecture) but also to the meanings and mental models associated with an area of knowledge (Holland et al. 1986; Thagard 1996; Gavetti and Levinthal 2000). Within such knowledge domains, needs are expressed and requests for solutions are posed.[21] For example, members of the community of the filmmaking industry share technical knowledge on how to make and promote films, but also certain ways of thinking and cultural traits related to how people should behave in order to be considered members of this community.

At this point, one might ask how and why some domains appear familiar or, in other terms, how agents gain competence over certain knowledge domains. The literature on creativity and innovation building in social networks has shown that knowledge domains are shared within social communities and that, according to an agent's position in a given social community (i.e., at the core or at the periphery), the agent will be more or less focused on (and absorbed by) the knowledge mirroring that community.[22] As a result, the agent will be more or less able to bring in new knowledge and generate creativity and innovation (Burt 2004; Perry-Smith and Shalley 2003; Fleming et al. 2007; Fleming and Waguespack 2007; Shalley and Perry-Smith 2008; Cattani and Ferriani 2008; Frigotto and Riccaboni 2011; Perry-Smith and Mannucci 2015). Building on these contributions, it is possible to add to the picture on the dynamics of the generation of novelty that an agent's to search, understand and imagine connections between

problems and solutions originally belonging to different knowledge domains reflect the agent's social connections with different communities.

The literature shows that there are different ways in which agents can play out the so-called bridging role between communities and domains of knowledge. At least three can be identified. Powell, Packalen and Whittington (2010) discuss the roles of the "800-pound gorilla" and the "anchor tenant". The "800-pound gorilla" agent dominates the other agents in his community, controls activities and designs engagement by maintaining his lead over problem definition, solution development and the construction of their link. In this case, whether the problem–solution pair is successfully developed into novelty depends largely on the 800-pound gorilla's abilities and problem framing. By contrast, anchor tenants in malls are leading tenants, whose prestige and name recognition attract other tenants and shoppers; in other words, they act as general facilitators and connectors of otherwise disconnected actors. Metaphorically, the anchor tenant in novelty generation is a well-connected actor, such as a university, a nonprofit institute, a venture capitalist, or a firm, which mobilises others and fosters collective growth. In this second case, the anchor tenant's engagement depends on prominence due to size and reputation, rather than design and control over what should happen. In addition, in this situation, the anchor tenant's ability to take the lead in problem definition, solution development and the construction of their link relies on the initiative of the involved actors.

Going further down along the dimensions of agency and control over problem definition and solution, it is possible to consider a third case that can be observed in cases of serendipitous innovation and creativity. This case is embodied by "the prince of Serendip". As will be illustrated in the next section, in serendipitous cases, the relationship between the domains in which the problem and the solution emerge is so remote that not only does it lack a foundation in research but also it is not even being knowingly considered.

The 800-pound gorilla, the anchor tenant, and the prince of Serendip imply a decreasing degree of agency and control in problem definition, solution development and the construction of their link. Given the

limits of agents illustrated in the previous pages, this ordering of cases should also reflect a decreasing degree of dependence on and limitations stemming from the agent's knowledge domains. The next section will focus on cases of serendipity, which may be more likely to provide "genuine novelty".

6.4.3 The Case of Serendipity

The case of the 3 M Post-it product is a good example of serendipity.

Chemist Spencer Silver discovered a new substance that did not fit a familiar category, since it was an "impermanent adhesive" in the field of glue. Regarding his invention, Silver claimed, "They want to call it 'a mistake that worked.' I like to think of it as a solution that was looking for a problem to solve" (Lindhal 1988, p. 14, quoted in Garud et al. 2011, p. 595). It took from 1968 to 1977 for the discovery to reach the first test sales in the market in which different uses of the non-gluing glue were attempted (Hiskey 2011). The market itself, which had not envisioned that the "non-gluing" glue was an interesting solution to several problems, received a positive response among offices. Several years after its discovery, 3 M chemical engineer Arthur Fry found a use for the "non-gluing" glue. More specifically, when he would sing in a choir, he had trouble keeping track of the pages in his hymnbook since his page markers would continuously fall out of the book. As a result, he used the low-tack adhesive to adhere little notes to the book itself. This different perspective suggested a different use and lead to the prototypes of the Post-it Notes that we know of today. In this form, Post-it Notes found a broad adoption in offices by accidentally experimenting with them. In the latter case, the problems to which the Post-it Notes responded were not explicit or formulated, but accidental.

The story of 3 M Post-it products is often told as a story of serendipity for many aspects.[23] However, the connection between the discovery and its many uses (i.e., between the solution and the problems) is generally less considered. In fact, for those who were searching for applications, the connection to the problem of the page marker was accidental (i.e., not deliberate or expected), meaning that the problems occurred

in contexts that were distant or negligible to them. Moreover, reaching the perspective in which these contexts were relevant, it took time and it was not part of the search program.

Serendipity is defined as the accidental discovery of something that one is not in search of, but it turns out to be valuable (Walpole 1960, pp. 407–408; Cunha et al. 2015, p. 10). Merton and Barber (2006) charted the term "*serendipity*", since its coinage in 1754 by Horace Walpole, and highlighted that the modern acceptance of the word stresses the sagacity of alertness and continuous observation over the accidental appearance of elements. In fact, they included serendipity among the scientific methods, alongside purposeful discovery by experimentation (von Hippel and von Krogh 2016). In fact, the origin of serendipity can be found in Persian traditional tales; however, it became popular in the English culture through the tale of the *Three Princes of Serendip* by Horace Walpole.

In the perspective that this book is attempting to build, serendipity occurs when solutions are found without having formulated problems. For example, the "non-gluing" glue was a serendipitous novelty for the individual discoverer, who found a solution to an unasked question. It was also a serendipitous novelty for those who were searching for applications in offices, since it appeared in a *context* in which they had not envisioned. Thus, serendipity occurs when solutions are found in relation to problems that have not been posed or have been posed in other (distant) contexts. Other cases could be reported to explore this conceptualization of serendipity. A more recent case is Botox, which was originally used for the experimental treatment of a rare eye disorder (von Hippel and von Krogh 2016). A dermatologist, having accidently heard about the collateral effect of the treatment that made the patient look younger, considered Botox for potential use in cosmetics and esthetic treatment.

To some, serendipity coincides with "luck", and it suggests the defeat of human rationality (e.g., Felin and Zenger 2016). While some casualty might occur in the effective or timely encounter of the missing part (i.e., solution or problem), other contributions have attempted to explain what preparation is so that "fortune can favor the prepared mind". In other terms, they have asked what can deliberately be done

or what can agency do in order to favour serendipitous encounters. As such, serendipity has been conceptualised as a capability (De Rond 2014) or an "energetic quest" (Denrell et al. 2003, p. 989). In this author's opinion, preparation resides in the structural and behavioural solutions that allow the connection and the exploration of different (and distant) contexts.

Extreme cases of serendipity show that the matching between problems and solutions that belong to distant contexts cannot always depend on the agent's ability to formulate a problem and build an appropriate solution. This is due primarily to issues of distributed knowledge and bounded rationality. In some cases, the agent's intelligence is limited to the ability to recognise what is revealing in front of him, rather than to designing and controlling the problem formulation and the development of a solution. As an implication, the cases of serendipity show that there is a limit to the problems that can be deliberately asked and the search programmes that can be pursued, at least within the classical model, in which the problem definition and the problem solution belong to the same controlling actors. This is consistent with the literature's suggestion that, when starting from a distant context, it is difficult to even imagine the solution that should be built. This is not to say that control over novelty is impossible; rather, it suggests that control over the formulation of the problem, the solution, and their link must be deeply rethought in order to include this kind of manifestation of novelty.

6.5 Strategies for Achieving Genuine Novelty

In the traditional view, a single organization attempted to nurture novelty internally, and this organization was the locus where the entire process of novelty generation was designed and controlled and where novelty actually occurred. Starting from the late 1980s, attention moved away from the single organization, and the locus of novelty moved to the networks of organizations that act together. In addition, the novelty generation process was redistributed; that is, the birth of novelties was entrusted to external providers (either competitors or start-ups), and organizations that previously developed in-house solutions purchased

them from the market or imitated them to increase competition by offering complementary assets or upgrading the products to draw the highest value. This is the model of open innovation in a "nutshell" (Chesbrough 2006; Chesbrough and Bogers 2014; West et al. 2014).

Conditions that pushed for the emergence of this model (also called "erosion factors" for the traditional model) include: the increased mobility of workers, which makes relevant competencies and social capital less sticky to organizations; growing access to venture capital and other forms of funding for early stage projects; more capable universities and other research providers (Chesbrough 2006), increasing specialization of knowledge (van den Ende et al. 2015); and the rise of Web 2.0 and social media, which has made it possible to reach a broad range of providers with cognitive and experimental knowledge at little to no cost (Chesbrough and Bogers 2014).

As the phenomenon moved from the start-ups related to organizations (to reduce risk) to the network of effective novelty producers, two changes resulting from these modified conditions are striking, but poorly understood. First, the availability of IT tools, which allows organizations to reach a large number of potential idea generators and collect their ideas at little to no cost, shifted the problem to the increasing cost of selecting the generated ideas. Second, the increasing specialization of scientific, technological and user knowledge made clear that organizations' most critical problems no longer lay in the search for solutions, but in the organizations' decreasing control over the knowledge specializations required to assess/select ideas, to define the problems that needed to be solved and to obtain the experts needed to solve them. As a result, this strategy of novelty generation seems very promising for the discourse of this book, as it provides organizations the opportunity to achieve novelty despite lacking the knowledge to pursue it internally.

6.5.1 Open Innovation as an Open Search for Problem Representations and Problem Solutions

Innovation that is "open" can have diverse forms and diverse contents. To some extent, the different labels adopted for addressing these forms

and contents overlap (see the list in Sect. 6.1); however, the phenomenon of searching for innovation outside organizational borders has attracted increasing interest from both scholars and practitioners.

More traditional forms of organizing, such as outsourcing, in which organizations make use of external resources for their production, have long histories in organizational practice and theory. However, historically, outsourcing practices have concerned non-strategic, typically manufacturing tasks, while design and innovation have been kept within the organization. Other forms of collaborations with third parties have typically taken the form of long-term contracts (to manage the issues of idiosyncratic investments or uncertainty) or partnerships. What open innovation (as a general phenomenon) has changed is the idea that, among other factors (mentioned in the previous section), innovation can often be more competently and more affordably generated outside the organization. Note that, when we speak of crowdsourcing, we typically speak of organizations entrusting a non-previously identified set of actors with problems requiring the production of novelty in the form of technical or scientific knowledge. However, crowdsourcing may also include simple repetitive and non-innovative tasks (e.g., through Amazon's Mechanical Turk). Conversely, when the term *broadcasting* is used, it typically implies a solicitation to solve a difficult problem through some sort of generation of novelty. Broadcasting takes place through the disclosure of problem details and through invitations to anyone who feels able to solve the problem (Jeppesen and Lakhani 2010). It typically takes place through contests or calls for solutions that are open to the public and that offer prizes for the best solutions. While broadcasting is a practice that has been used since the 1600s (Dahlander and Jeppesen 2014), it has recently grown exponentially through such so-called innovation platforms as InnoCentive, NineSigma, Yet2.com, TekScout, IdeaConnection, YourEncore, Innoget, BigIdea Group, InnovationXchange, Creax, Ocean Tomo, and others.

Empirical work has begun to shed light on these forms of open innovation in order to understand the breadth and depth of search (Laursen and Salter 2006; Garriga et al. 2013), effectiveness (Jeppesen and Lakhani 2010), participants' motivation and incentives (Boudreau et al. 2011), financial performance (Du et al. 2014) and research paths

(Lopez-Vega et al. 2016). In addition to theoretical interpretations of such empirical evidence, theoretical framings are also being formed (Afuah and Tucci 2012; Nickerson et al. 2016; Felin and Zenger 2014, 2016; von Hippel and von Krogh 2003, 2016; Haas et al. 2015; Piezunka and Dahlander 2015). While a review of these contributions lies beyond the scope of this discourse, some of these studies provide interesting insights into this book's arguments concerning novelty.

The generation of novelty through open innovation systems, identified with no particular consistency in terms of broadcasting, crowdsourcing, or crowding, has been explained within the literature on decision making and organizational learning (see Sect. 3.6) as a strategy for performing distant search. In general, such novelty generation is defined as "the act of outsourcing a task to a 'crowd', rather than to a designated 'agent' (an organization, informal or formal team or individual), such as a contractor, in the form of an open call" (Afuah and Tucci 2012, p. 355). As such, it represents a solution to the typical limits of adaptive systems, which prefer to search for novelty by building on existing internal knowledge and which have the tendency to choose less innovative, more familiar and better quantifiable targets (Levinthal and March 1993). As a matter of fact, through crowdsourcing, organizations can search for knowledge externally, allowing them to find solutions that derive from different and distant domains of knowledge. Moreover, crowdsourcing allows organizations to reach actors that access problems from different starting points, thus displaying different rates of difficulty and success in identifying high-value solutions. This is particularly important because distant knowledge has the greatest potential for providing "genuine novelty" (Singh and Fleming 2010[24]; Piezunka and Dahlander 2015); thus, through this strategy it should become possible to reach distant knowledge that could have not been reached solely through an organization's internal search path.

This stream of literature has typically assumed the fitness landscape resulting from Kauffman's NK model as a mapping of the performance of alternatives available to the agent and has claimed that the agent prefers local search (e.g., Afuah and Tucci 2012). In crowdsourcing, the so-called "focal actor" (i.e., the one who posts the problem and calls for solutions; also called the "knowledge seeker"), defines the problem,

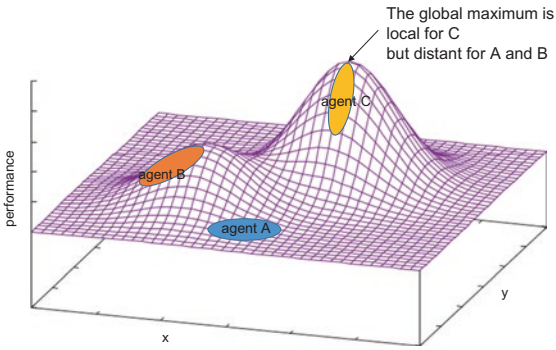


Fig. 6.4 Distant search through local search

and all of the contributors subsequently examine the problem within the problem frame established by the focal actor. The dimensions of the landscape represent the explanatory variables that build the problem representation (i.e., how the problem is cognitively understood), and the points in the landscape are metaphors for the problem's solutions. The focal agent cannot see the entire landscape, since he is not fully rational. However, each contributor can see and explore (at reasonable cost and time) the landscape's local area: that is, the area located around his position, which represents a more familiar knowledge domain (see Fig. 6.4). Agent diversity is beneficial, since diverse agents provide different entry points into the landscape.

This framing facilitates an understanding of the potential of open innovation strategies. It also conceives of the solutions that can be reached through such strategies and their pursuit of a wider scanning within the *same problem representation* (i.e., one specific landscape within the NK model). Moreover, from this perspective, agents are modelled as having a partial understanding of the problem representation of the perfectly rational agent, which reflects an understanding of bounded rationality in terms of non-complete access to a set of solutions. Within this framework, crowdsourcing facilitates the generation of novelty through the broader exploration of solutions within the same problem representation by connecting several bounded and rational agents.

While this conceptualization is both simple and powerful in showing the role of diverse agents connected through an open innovation

system, it cannot fully account for some of the empirical evidence reported in the literature. Evidence on open innovation has produced some insights that seem to suggest that open innovation supports different kinds of distant search and that the resulting novelty should also be conceived in more specific terms.

First, Sieg et al. (2010) and Lopez-Vega and colleagues (2016) showed that: (a) organizations crowdsource several different kinds of problems, seeking different kinds of solutions ranging from new technical innovations to revolutionary scientific approaches, meaning that posted problems display different degrees of problem definition, and (b) according to the kinds of solutions required, problems can be formulated in different ways and with different types of language, ranging from technical and applied to more general and abstract. This evidence suggests that open innovation supports the generation of different kinds of novelty related to different kinds of problems.

Second, Lakhani, Jeppesen, Lohse and Panetta (2006) and Jeppesen and Lakhani (2010) analysed the efficacy of problem solving produced through InnoCentive between 2001 and 2004.[25] They showed that the likelihood of developing a winning solution increases when the distance between the problem and the solver's field of expertise increases. This evidence disrupts the general idea that those who have experience and knowledge in a problem domain are most likely to develop successful solutions. According to this stance, for example, a chemical engineering problem would be more likely to be solved by a chemist than by a biologist. This evidence triggers two intuitions: (1) solutions are found either (i) through analogies with other problems in different fields or (ii) through re-formulations of the problem that allow the original problem to be re-defined along different dimensions; and (2) the representation within which a problem is originally considered might differ from the problem representation that allows access to the solution.

6.5.2 Problem Representation and Problem Definition

The studies on open innovation presented above facilitate a deeper conceptualization of both open innovation and novelty along two levels of

analysis. First, while open innovation allows the generation of "genuine novelty", it addresses a range of different kinds of problems. It might be simplistic to include these problems under the extant concept of "distant search"; instead, it may be best to distinguish among them. Second, novelty derives from such different kinds of problems in a variety of ways and forms. Further distinguishing these may help to better define novelty and its dynamics.

On the first level, to discriminate among different kinds of problems, one possibility is offered by Lopez-Vega et al. (2016), who proposed that problems requiring experiential wisdom or cognitive intelligence to solve could be categorised. However, building on the differences between the two forms of knowledge identified by Gavetti et al. (2005) and Gavetti and Levinthal (2000), we prefer, in this book, to build on the categorizations/concepts of *problem representation*, which includes experiential wisdom or cognitive intelligence as special cases, and *problem definition*, with problems ranging from well- to ill-structured definitions. Building on Simon (1991, 1973; Newell and Simon 1972), a problem representation is an understanding of a problem articulated as explanatory dimensions or variables. Given a representation of a problem, also called a problem perspective by Page (2007; Hong and Page 2001, 2004), a set of possible solutions can be derived through the specification of a search heuristic within the representation.[26] However, not all problem representations have the same degree of definition. In fact, problems can be classified into well-structured problems and ill-structured problems. Well-structured problems have precise problem representations, which support "an algorithmic method" (i.e., in which explanatory variables are analytically identified). An example of an algorithmic method is the NK model, which begins with a well-structured problem representation, because it generates a landscape that is searchable (von Hippel and von Krogh 2016). Ill-structured problems have not been transformed into a solvable problem representations and explanatory dimensions have not been identified. They typically suggest that several competing problem representations can be constructed and that their validity is still being assessed.

On the second level of analysis, which focuses on novelty, the implication that can be built from the previous level is that different novelties

arise in different situations. When a problem representation has been identified, novelty concerns new solutions within that problem representation. By contrast, when competing problem representations are still being generated and assessed or when a problem representation has been identified but higher-performance solutions could be found by changing this representation, novelty concerns new solutions in new problem representations. The next section will address these cases more in depth.

6.5.3 White Novelty from Ill- and Well-Structured Problems

Building on the argument developed in the previous section, we can identify two typical problem situations, representing ill- and well-structured problems, along the dimension of problem definition. These extremes reveal two different kinds of novelty: one that derives from the re-formulation of the problem, and one that consists of a new solution within the same problem representation. We can then add a third situation, which, in several respects, represents an intermediate case. These three situations embody three different kinds of distant search, whose illustration is also synthetised in Fig. 6.5: exploration through dimensioning, analogy and greater workforce.

First, a problem that is ill-defined or ill-structured is difficult to formulate into explanatory dimensions that allow to access solutions (Newell and Simon 1972; Simon 1973, 1991). Note that a problem's positioning in terms of its definition (i.e., ill- or well-structured) can also change over time. Ideally, a problem definition will improve, for example, due to the availability of new scientific theories that suggest ways to address the problem. However, there is also the case of revision, when elaborated explanatory dimensions prove wrong, do not allow access to valid solutions, and, thus, require revision. In this case, novelty consists of new solutions that derive from the formulation (or a re-formulation) of the problem.

Consider, for example, the case of puerperal fever, which is a disease thought to affect women within the first three days after childbirth and

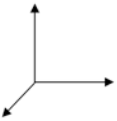
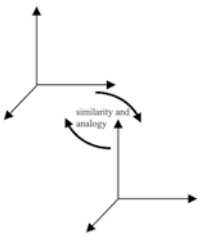
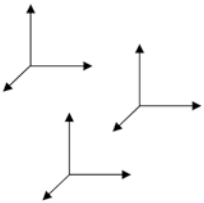
Kinds of distant search (from the focal agent perspective)	Exploration through more workforce	Exploration through analogy	Exploration through dimensioning
Typical situation	500-calorie meal situation	Staples - Toys 'R' Us analogical situation	Puerperal-fever situation
Problem definition	HIGH Well-structured problem ←	→	LOW Ill-structured problem
Problem representation	One problem representation 	One problem representation, other analogical problem representations 	What problem representation? 
Distance between the representation where the problem is (initially) raised and the representation where the solution is searched	ZERO ← Problem and solution are found within the same representation.	MEDIUM/HIGH The solution is searched in a different problem representation, but is then transferred to the initial representation where the problem was raised.	→ HIGH The problem is reformulated and newly represented.
Target	Distant solution within a known problem representation	Very distant and difficult to reach solutions within known problem representation	Extremely distant solutions in new problem representations
Form of question	Context specific problem formulation	Context specific problem formulation but with cross-field technical terms	Focus on the target performance; open problem formulation: non-context specific, but abstract terms
Potential solvers	Experts in the field	Experts in the field with experience in other fields; Experts in different fields	Experts questioning the existing field and traveling across problem representations; Experts in different fields
Diversity	Different entry points within the same problem representation	Different entry points through different problem representations	Different problem representations
Solution strategy	Mechanical turk	Analogy	Dimensioning

Fig. 6.5 Novelty from different kinds of distant search

which could result in death. This disease has been known since ancient times, and several theories have attempted to understand it and find a treatment. For example, Nuland (2004) reported that, in the eighteenth century, the most accredited theory was the milk-metastasis theory; that is, it was believed that breast milk was made of transformed menstrual fluid, which reached the breasts through a duct positioned between the top of the uterus and the tip of the nipple. Autopsies on women who died of puerperal fever found pus in their abdomens, which looked like deteriorated milk. Thus, some claimed that the milk had deviated from its normal path to the breast, had accumulated in the abdomen, provoked the disease, and caused death. Other theories

claimed that the disease was provoked by a fear of death. Around 1845, Ignaz Semmelweis developed the theory that puerperal fever was due to "cadaverous particles" doctors transferred to new mothers when they visited them after conducting autopsies. Requiring the doctors to wash their hands decreased the mortality rate below 1%. Although Semmelweis' theory was initially rejected by the medical community, it was ultimately acknowledged after Louis Pasteur demonstrated the germ theory around 1860. These examples show that, over the centuries, several explanations and solutions for the puerperal fever problem were provided, many of which were not at all related to the problem's real explanatory dimensions. Semmelweis' theory, which was the most accurate, was so distant from common expert understanding that it was not understood or believed.

In general, ill-structured problems create cases in which the agent lacks a clear framework with which to understand the problem, and this gap is reflected in an indefinite problem representation. The puerperal fever situation represents a specific version of this general case in which a structure was attempted but achieved displeasing solutions. In other terms, in cases of ill-structure problems, the boundedly rational agent has a perspective on the problem that does not capture the real explanatory variables and, thus, can typically only access solutions with low performance value. Interestingly, in such cases, the achievement of displeasing solutions can reveal that the problem has not been properly understood. This book will refer to this phenomenon as the *puerperal fever situation*. This situation stresses the issues of the ill-structured problem and the difficulties of revising and changing a structure. In fact, the path to a solution involves creating and considering different problem perspectives, which compete with and eventually substitute for previous representations. It is often very difficult to affirm a new problem representation when prior representations have been shared and trusted, especially when the new representation relies on novelty that has not yet undergone the processes of transformation and institutionalization (Sect. 6.3). The difficulty raised by the puerperal fever situation stems from the fact that the initial problem arises from one problem representation, while the solution arises from another. While it is always difficult to adopt a new problem representation, it is important and

relevant to consider the "distance" between two representations, which stems from the relations between and proximity of their knowledge bases, as well as on the changes to established beliefs necessary to shift from one representation to the other.

At first glance, the puerperal fever situation might appear to better reflect a scientific revolution than an actual organizational problem. However, organizations pose questions (e.g., through crowdsourcing) that seek this exact type of revolutionary impact. For example, Arcelik sought solutions for a washing machine that did not require the use of water without offering any suggestions on how such a machine could be made (Lopez-Vega et al. 2016). This kind of is called dimensioning.

Second, well-structured problems with bounded rationality can be modeled as partial views of the complete problem representation. In such situations, the available perspective is the perspective that provides a *perfect* understanding of the problem (of perfect rationality) and an *exact* identification of the set and dimensions of solutions. However, given agents' condition of bounded rationality, each agent has only partial access to solutions. In this case, novelty appears as unknown solutions within the same problem representation. Consider, for example, all of the possible combinations for a meal of 500 calories. Of this total set of options, vegetarians would only consider some solutions, while vegans and gluten-free individuals would choose others. This book will refer to such cases as the *500-calorie meal situation*. Here, the solution path concerns the aggregation of the agents' partial solutions. This situation also concerns problems for which the main explanatory variables have been identified but the performances of their combinations are not all known. This kind of distant search is performed by increasing the workforce (e.g., through the Mechanical Turk platform).

Between these two extreme cases, it is possible to position the case of analogy, which is a typical search strategy that draws solutions by importing them from other similar problems. For example, Sherwin Williams sought a way to delay the drying process in water-based emulsions in response to new government regulations requiring firms to reduce the content of volatile organic compounds. Since these regulations affected several industries, he anticipated that the solution could come from unrelated industries, such as food or paper (Lopez-Vega

et al. 2016). Further, consider how Thomas Stemberg, with his background as supermarket executive, thought of Staples, the office supply superstore: "He posed the initial strategic insight as an analogical question: 'Could we create a Toys 'R' Us for office supplies?' (Stemberg, 1996). The basic supermarket formula—exhaustive selection, low prices and margins, and high volume—has been applied in a wide range of retail categories" (Gavetti et al. 2005, p. 693). Building on the story of the foundation of Staples as an analogy of Toys 'R' Us (and many others), Gavetti et al. (2005; p. 693) described: "The managers we consider discover new positions neither by reasoning from first principles of economics nor by undertaking unguided local search. Rather, when faced with a new and complex setting, managers identify the features of the setting that seem most pertinent, think back through their experiences in other settings with similar features, and recall the broad policies that worked well in those settings." In this situation, which will henceforth be called the *Staples–Toys 'R' Us analogical situation*, novelty takes the form of a solution within an established problem representation that would have not been easily reached.

While these categories seem to be drastically different, it is important to note that it is not always clear to which category a certain problem belongs. Single organizations addressing certain problems are limited, and it might not be clear whether others have faced the same challenge (i.e., which would allow an analogy to be built) or if the problem reveals a more fundamental *puerperal fever situation*. Similarly, it is not easy for a focal agent to understand his position in relation to the problem. In other words, is his representation one that is close to "the perfect one" (of the absolute rationality), or is it similar to that of most doctors when Semmelweis proposed his theory?

6.5.4 What Questions, What Solvers, and What Solution Strategy?

Clarifying both the type of problem and the position of the focal agent is important, since both impact which solution is desirable and which solution will actually be sought. The focal agent is the one who

formulates the problem and, thus, provides a problem representation that is more or less structured. In keeping with the idea that what is found depends on the questions asked (Lopez-Vega et al. 2016), the definition of a problem representation implies the definition of the most likely solution strategy, the potential solvers who will engage in the search and the kind of novelty that will be produced (see the second part of Fig. 6.5). Building on Lopez-Vega et al. (2016), the following paragraphs analyse the three cases.

In the puerperal fever situation, the targeted solution is extremely distant, as the problem representation undergoes a reformulation. In order for such a transformation to be suggested, the question must be sufficiently abstract from the specific context and must refer only to the targeted performance (e.g., "reduce mortality rates of women after delivery"). It is possible to add data to the phenomenon; however, in order to build hypotheses concerning why the phenomenon occurs and, thus, which solutions should be derived, the solver must conduct some research. Potential solvers are encouraged to provide solutions from different perspectives. These typically come from different fields, or they would be embedded in the established knowledge and beliefs of the field in which the problem arose. A potential solver is one who shows: (1) the ability to bridge the distance between the problem representation where the solution is found and the problem representation where the problem arose and (2) is not cognitively or socially bounded to the core of the field in which the problem arose. As a solution strategy, this situation requires what was previously described as dimensioning.

In a Staples–Toys 'R' Us analogical situation, a specific problem is described using technical terms that are common to a variety of industries or knowledge domains. For example, classical musical opera theaters of the grand tradition in Italy face budget restrictions, managerialism, and a general aging of the classical music public. Organizations/individuals in other realms may have faced similar experiences, and their insights could illuminate the situation and suggest possible strategies for dealing with these trends. In such cases, potential solution providers have experience with analogous problems in other industries. In terms of solution strategy, such situations call for the use of analogy.

In the 500-calorie meal situation, problems are clearly positioned within a perspective that is defined in relation to a specific context (e.g., "What could I eat in a 500-calorie meal?"). Imagine such a question being posted on the Internet, where it could leverage cultural and gastronomic diversity on a global level. Potential solution providers could refer to the same problem representation and post their solutions, which may appear more as computations than as possible problem frameworks. Individuals may be experts within the same field but be diverse in the sense of having different entry points to the problem representation. In such cases, the solution strategy provided by all those systems facilitate the engagement of more solvers. If a problem does not require specific knowledge, Mechanical Turk could be an option. Otherwise, other platforms of open innovation or direct outsourcing may be appropriate.

Here, the three cases have been analysed with respect to the traits and properties one would need to clarify in the event of a call for open innovation. Through the open innovation system, novelty is pursued in a deliberate way, even though design and control assume diverse meanings in the three cases. In the puerperal fever situation, the focal actor has no control over either the solution or the process adopted to reach it; the only design concerns the target level of performance, and there is no control over the problem representation. In the Staples–Toys 'R' Us analogical situation, the problem representation is designed and the solution is targeted and associated with a solution strategy (i.e., "use analogy"). In the 500-calorie meal situation, the problem representation is designed and both the solution and the solution strategy are well identified, so control over the outcome is very high.

In some cases, crowdsourcing specialists can assist organizations in understanding the category to which their problem belongs. This phase has been acknowledged to require significant time and effort (Sieg et al. 2010; Lopez-Vega et al. 2016). When problems have not undergone such an assessment, it is not surprising when solvers appear as "unusual suspects" (i.e., solvers that one would have not anticipated; Lakhani and Jeppesen 2007).

Moreover, it is not always clear whether a problem falls into the puerperal fever situation, the Staples situation or the 500-calorie meal

situation. Consider, for example, that to most doctors in the nineteenth century, puerperal fever was the "right" problem representation, within which solutions would have improved. To them, because they were not looking for other kinds of solutions, the unpopular "cadaverous particles" hypothesis would have appeared somehow serendipitous. A similar argument could be built drawing on clearer cases of serendipity, such as the microwave discussed previously in this chapter. Though serendipity is often defined as a solution for a problem one was not seeking to answer, this discussion suggests that serendipity may be better defined as a solution for a problem one was unable to properly define in terms of problem representation. The "right" problem representation is the representation that facilitates the development of better solutions. In fact, as awareness improves, expectations regarding the types of people who could become solvers (or "expected suspects"), as well as the precariousness of the initial problem representation(s), increase. Particularly in puerperal fever situations, in addition to finding solutions, an equally important goal is to find the problem representation that facilitates a correct understanding of the case. As Nickerson et al. (2016) claimed, through crowdsourcing, we look for both solutions and problems.

Notes

1. Democratised innovation can be seen as the more general concept acknowledging the community of users as both innovation generators and stakeholders interested in the development of innovation.
2. Distributed innovation builds more broadly on the idea of distributed knowledge by Hayek (1937), and it is positioned in the same stream with von Hippel's democratising innovation.
3. There is some confusion regarding the use of open innovation, due to inconsistent usage (Chesbrough and Bogers 2014). Open innovation, referring to Chesbrough (2006), as opposed to closed innovation occurring within organizational boundaries, is innovation deriving from knowledge flows across organizational boundaries. However, open innovation has also been used as a synonym for user-centric innovation, building on the open-source model in which innovation is a public,

non-rivalrous, and non-excludable good produced at low or no cost (e.g., Baldwin and von Hippel 2011).

4. Broadcasting is an innovation process, rather than a type of innovation, through which the details of a problem at hand are disclosed and anyone is invited to solve the problem, especially those who deem themselves qualified to produce a solution (Jeppesen and Lakhani 2010).
5. Crowdsourcing specifies that innovation is derived from problem finding as well as problem solving. Crowdsourcing includes both "crowd *finding*—problem finding through the crowd—and crowd *solving*—problem solving through the crowd" (Nickerson et al. 2016, p. 3).
6. Piscopo and Birattari (2013) stressed that discovery and invention form a dichotomy that reflects the tension in epistemology. In line with the perspective of Francis Bacon and John Stuart Mill, knowledge is *discovered* by induction from the simple observation of nature. Conversely, Poincaré and Popper raised the epistemological issue regarding the objectivity of science. They recognised that scientific laws are produced and they do not directly descend from observation. As such, they are invented as laws about nature, and not discovered as laws in nature.
7. Mintzberg (1978) and Mintzberg and Waters (1985) developed the concept of strategy as a process of actions and decisions, and showed that novelty does not play a role in the initial conceptual stage of strategy, which typically concerns planning. However, it continuously emerges in changing circumstances and is continuously produced in response to them. While the literature has focused on "intended strategy", assuming that the planned flow of actions and events is realised, and leaving any change as merely concerning the implementation stage, they stressed the role of unpredicted aspects and events as well as the changing internal dynamics that impact and change the intended strategy. In fact, the "intended strategy" is realised into a "deliberate strategy" when three conditions are satisfied, which is extremely rare (Mintzberg and Waters 1985): (1) When organizational intentions are clear and detailed; (2) When the strategy is shared by the entire organization; and (3) When the strategy is realised as intended. In other words, this is only a realistic case when (it is assumed that) the context is "perfectly predictable" and "benign", meaning that the organizational coalitions have reached a truce "under the full control of the organization" (Mintzberg and Waters 1985, p. 258). The well-known case study regarding the launch of Honda motorcycles in California by Pascale

(1984) showed how far and speculative these conditions are in real life. The rational school voiced by the Boston Consulting Group described this as a case of excellent strategic planning in which correct intentions had been realised. However, Pascale collected empirical data showing a different story. Honda's managers revealed that the company's success in the United States was the result of a casual approach, which did not build on accurate analysis or precise planning. Conversely, they adapted external circumstances in an attempt to learn from their actions and failures. Moreover, they performed a strategy that allowed them to better understand the context in which they were participating (and not just to predict it), and perform actions that were completely consistent with this context. The Honda strategy is an example of Mintzberg's "emergent strategy" or "learning strategy". In contrast with intentional strategies, emergent strategies characterise unpredictable contexts as well as lively and unstable social order in organizations that do not fit any aspiration of control or any interpretation/design of the organization.

8. This author wishes to thank Emily Judd for drawing attention to this case.
9. Durand and Khaire (2016) discussed category creation in the first case and category emergence in the second case. However, this book prefers the term "*category formation*" as a novel category created from reshaping existing categories. As in this discourse, "emergence" implies the lack of control by individuals or organizations on change and novelty dynamics, while the aforementioned authors allow individuals or organizations to act strategically in order to achieve competitive leadership through category formation.
10. Durand and Khaire (2016) premised that these two are ideal types. However, they provoked a certain dissatisfaction, which exceeds the natural imperfect correspondence between actual cases and ideal types.
11. There is a heated debate on whether such products for society should be sustained by the public or whether they should find their own sustainability.
12. Padgett and Powell (2012) referred to *Novelty one* as *innovation* and *Novelty two* as *invention*. Here this author does not report these two types of novelties with such labels in order to allow the reader to focus on the meaning of such distinction, rather than being misled with the mainstream meaning of such words. In fact, Padgett and Powell used

the meaning in the opposite manner (i.e., they associated the conventional meaning of the one to the other and vice versa), producing considerable confusion and some contestation.

13. According to the European definition, a rare disease is a serious or lethal illness affecting less than one person for every 2000 individuals (75 cases out of 100,000 individuals, according to the U.S. definition).
14. Rett Syndrome is a genetic neuro-developmental disorder that appears in infancy and predominantly affects girls. RTT patients are normal at birth and during early development, but after the sixth month, they display postnatal deceleration of head growth, psychomotor regression, gait dysfunction, and stereotypic movements such as the so-called "hand-washing."
15. The originality of the message of institutionalism was based on acknowledging that organizational behaviour occurs within and is justified by a framework of socially constructed, taken-for-granted guidelines/directions of appropriate conduct, especially when organizational behaviour was attributed to rational decisions (Scott 2001). While institutionalization cannot be ascribed to the intervention of one organization or individual, the active role of some individuals in systematic change has recently gained attention.
16. From the ANT perspective, *poisedness* aims at providing a different explanation, at the system level, regarding why some tentative translation processes initiated by individuals accomplish a complete translation process, e.g., successfully delineating OPPs or engaging people, while others fail.
17. The technology-push perspective has emerged in the late 1970s as a reaction to the mainstream claim that market-pull should be the only trigger (e.g., Freeman 1974, 1979).
18. Note that, as Basalla pointed out, the outcome of the problem-solution search is not indifferent from the starting point (1988). The same problem or solution involved in a market-pull or technology-push process might end up with different outcomes. For example, the mobility problem would have been solved by the users imagining "faster horses", while from the technological field, it was solved through the invention of the internal combustion engine (Basalla 1988).
19. Or vice versa: agents consider the connection between solutions in their domain with problems in distant domains.
20. The opposite also works.

21. Consider that the considerations will be carried on in terms of the agent, implying that this could be an individual or an organization. However, similar considerations can be built for the system level (Scott 2001; Powell and DiMaggio 1983).
22. In the previous sections this literature was mentioned in relation to the small-world problem.
23. The actual discovery of the polymer was accidental.
24. These authors refer to breakthrough innovation and not directly to novelty.
25. Their sample included: the research laboratories of 26 firms that disclosed 166 problems that could not be internally solved, and 80,000 independent scientists from more than 150 countries that provided solutions to one-third of the cases.
26. Page and colleagues (Page 2007; Hong and Page 2001, 2004) modelled agents as perspective-heuristic pairs which define the problem representation (or the problem-solution landscape) and the strategy for travelling through it in search of a high-value solution. Each pair identifies what solutions are found and how difficult it is to find them (i.e., how likely it is that the high-value solutions are found by randomising the starting point of a search or in how many steps it is achieved). Different perspective-heuristic pairs reflect diverse internal problem representations, and mirror diversity of knowledge, experience, cultural background and social communities. Problem representations might reflect what this book has previously called knowledge domains or contexts. As a result, problem solvability or difficulty is in the eye of the beholder. Thus, increasing the number of diverse solvers increases the probability of obtaining a solution.

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Part III

A Primer

7

A Working Definition and Tentative Models

7.1 Two Starting Points

Novelty is, by nature, difficult to understand and to define; that is, it does not exist if it is not genuinely new, even in our imagination (Powell and Padgett 2012, 1). The authors who diversely addressed the concept of novelty and its implications for organization studies (e.g., March 2010; Padgett and Powell 2012; Rosenkopf and McGrath 2011; Levinthal 2008; Becker et al. 2006; Garud et al. 2015) did not provide a definition of what they meant for novelty. Rather, they merely offered an implicit concept of novelty. As a result, there is no clear, univocal definition of novelty in the social sciences, as there is none in biology (Pigliucci 2008). However, novelty is observed and intuitively conceived as a prominent category, starting from its manifestations rather than from its speculations.

Novelty can be recognised in innovations, inventions, discoveries and creativity (positive novelties) as well as in new emergencies (negative novelties). Novelty reveals itself and is avoided (or limited) when negative novelty is concerned, while it is pursued when it manifests into positive novelty. These two attitudes towards novelty have supported

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the development of two perspectives on novelty: as something emergent (negative novelty) or something mainly deliberate (positive novelty). What this book attempts to do is to develop a line of reasoning that reverts these perspectives into one, which acknowledges and addresses the common base of novelty between these manifestations. It also asks how negative novelty can be included into a system of control regarding its manifestation and anticipation of its occurrence. This question attempts to understand how learning can be organized to expect the "unexpected". Moreover, it asks how it would be possible to give more room and relevance to emergent novelty in the realm of positive novelty, up to the point of imagining how to induce such emergence. As argued in the previous chapter, this question attempts to understand serendipity and open innovation where novelty emergence is recognised the most. This was done for two main purposes. The first purpose is to enforce the pursuit of novelty in the realm of positive novelty, and the defense from novelty in the realm of negative novelty. The second purpose (and the main motivation for this book) is to produce an understanding of novelty that is not dependent on the consequences (i.e., if novelty is positive, then it is invention, innovation, etc.; if novelty is negative, then it is new emergencies) or control, but an understanding that captures the fundamental properties of the phenomenon across the direction of consequences (positive and negative) and the possibility of controlling novelty formation.

From the analysis of negative novelty addressed in Chap. 5, this section reports the following considerations:

1. On the negative side of the novelty phenomena, a typical realm in which novelty can be systematically observed and studied is that of emergencies, disasters and crises. Emergency management was created to address such novelty, which consists of dreadful threats to humans or other valuable resources.
2. Novelty in this realm also includes a distinctive property, which makes it even more interesting. Novelty here is typically unpredictable. In fact, emergency management has recognised some regularity in events, based on the fact that, through experience, scholars and practitioners are able to depict the typical deployment and

criticalities of events. However, this does not mean that novelty is under control. Thus, novelty remains unpredictable in its timing, and since no event is ever the same, slight differences can be significant.

3. According to some practitioners and scholars, recent emergencies, such as the 9/11 terrorist attack, depart from regular events that emergency management was created to handle. They reveal a facet of novelty that is not captured by unpredictability. Instead, their timing and deployment have been ignored, and their manifestation appears to be "unthinkable". The study of the "unthinkable" allows one to address the issue of agency and control in novelty at its extreme. In fact, the "unthinkable" novelty depicts a case in which control and agency are extremely limited.
4. In the tradition of the Carnegie School, the origins of such limits to control and agency can be referred to the following: the cognitive limitations of the decision maker; the social and organizational nature of decisions; and the ill-structured nature of problems. As for the first aspect, individual agents are unable to think the "unthinkable" due to their limited understanding of available information (i.e., limitations in computability and attention), their tendency to overcelebrate, which makes them fall into "competence traps", and their inability to imagine what they have not previously experienced. As for the second aspect, collections of agents are limited by their interaction with agents, especially those with a limited understanding of the situation, and through imperfect communication and transmission systems. As for the third aspect, agents are unable to grasp the unexpected since it represents an ill-structured problem that he/she is unaware of, and attempting to seize it means building a problem representation within an indefinite space. Such a task requires the elaboration of assumptions and theories that offer a structure to the problem, which, in turn, enables the novelty to be seen.
5. Emergency management organizations have developed some tools that allow them to "strategise around" the "unthinkable"; that is, they do not aim to solve the unknowable future, which does not look like the past, but they aim to go around it and deal with it. Another perspective of using these tools is in terms of two major abilities that would be necessary for positive novelty: (1) the ability to notice and

recognise novelty that is not designed or predicted, and is not even considered to be possible; and (2) the ability to deal with novelty. In regards to the latter, for negative novelty, this means the ability to contain or avoid it, while for positive novelty, this means the ability to seize and benefit from it. In addition, they consist of the integration of the general and specialised sensor and reactor systems into variable architectures that allow one to scan for unfamiliar signals and implement early responses. Furthermore, they are able to change and work in parallel while events reveal themselves and learning is acquired.

From the analysis of positive novelty addressed in Chap. 6, this section reports the following considerations:

1. On the positive side of the novelty phenomena, invention, discovery and creativity refer to the generation of novelty with some nuances reflecting disciplinary preferences and habits. In addition, innovation refers to the elaboration of new and old elements into new implementations. This focus places exclusive attention on novelty that includes a scientific and technological origin, takes the form of manufactured products, involves formal R&D, typically occurs in large companies, and is patentable or patented. As a reaction, a perspective stressing the existence of the "hidden innovation" has recently gained attention, including social innovation, non-technological, non-patentable novelty, which proceeds incrementally and takes place in low-tech industries. Moreover, the focus of innovation has been on novelty appearing in products, processes, markets, resources, and organizational solutions. However, at the micro and macro level, novelty also appears in routines and institutions (i.e., institutional innovation). A focus on novelty clusters all of these manifestations and allows one to direct attention on the common underlying mechanisms of its generation and development, rather than on non-structural properties.
2. Attempting to understand novelty implies understanding what is old. However, when novelty components and the roots of novelty are analysed, the distinction between what is old and what is new becomes

blurred. Moreover, the stronger (or weaker) relationship between novelty and what is old does not explain how or when a novelty is considered relevant or important. A possible solution to this issue could be to define novelty according to its impact. Furthermore, this solution requires defining for whom or for what this impact should be considered. The literature has suggested considering the social impact on social communities (which change their structures), and the impact on meaning and knowledge, which might be labeled "a semantic impact".

3. Several factors support (or hamper) novelty, and several processes enable its complete formation. For instance, consider the analysis of bricolage and breakthrough development, and translation and catalysis implementation. The factors and processes of such forms of development and implementation explain the definition and acceptance of novelty, in terms of new meaning and the engagement of people or communities that recognise the novelty's potential and offer their support.
4. Novelty does not only occur when a problem is defined and the corresponding solution is searched. Frequently, novelty occurs through the association of autonomous problems and solutions that originally emerged in relation to a specific solution or problem. For example, in the technology-push model, typically developed within a context of research, agents search for solutions to solve specific problems, while in the market-pull model, they search for solutions that have been produced in relation to other problems (e.g., in science).
5. New ways of searching for innovation, which can be included among the open innovation systems, can be to rethink the usual conceptualization of problem and solutions as well as the typical search paths. In addition, the classical paths of exploitation and exploration have to be defined in relation to a focal agent (who posts the problem) or to the solution provider. In this regard, exploration for the focal agent corresponds to exploitation or exploration of the solution providers. Furthermore, there is another search path—*dimensioning*—whose target is not only to provide solutions but also to provide a problem representation that allows one to reach satisfying solutions. The search path that is triggered and the type of novelty obtained strongly depend on the questions presented.

6. What is identified as serendipity is often a case that reveals how our limited understanding of the situation, both in terms of what the explanatory variables of the problem are and what implications can be derived from the solution. Serendipity is an extreme case (*à la* Langley and Abdallah 2011) that allows one to move the focus of bounded rationality from the limits of finding the best solutions to the limits of building problem representations.

7.2 Novelty as New Knowledge

Novelty manifests itself into *technologies*, *theories*, *ideas*, and *behaviours*, through the processes of invention, discovery and creativity, into *products*, *processes*, *markets*, *resources*, *organizational forms* and *institutions,* through innovation processes as well as *new emergencies and unexpected occurrences* that represent "*the unthinkable*". A focus on novelty clusters all of these manifestations of novelty and allows one to direct attention to the common underlying mechanisms of its generation and development, rather than on non-structural properties. A definition of novelty must reflect such struggle for generalizability. However, the multi-faceted nature of novelty, along diverse manifestations, makes the construction of a robust definition and consistent understanding of novelty a challenging task.

In order to build a definition of novelty that may include all of these manifestations and nuances and that may trigger further research, we build on March's (1991) seminal work and on subsequent research (Levinthal and March 1993; March 2010), and take Rosenkopf and McGrath's (2011) suggestion that novelty can be defined in terms of new knowledge *that novelty manifestations may provide, require or demonstrate.*[1] In fact, new technologies, theories, ideas, behaviours, products, processes, markets, resources, organizational forms and institutions demonstrate that new knowledge needs to be further developed in order to enhance adoption. New emergencies representing the "unthinkable" require the formation of new knowledge that is addressed and anticipated.

On the one hand, this definition allows one to set a common ground for seizing the complexity of the novelty concept and the variety of

the phenomenon. On the other hand, novelty includes the ambition to capture and complement the single concepts of innovation, creativity and invention as well as move the discussion forward by focusing on a shared basis—knowledge—instead of the peculiarities of its single manifestations.

7.3 Models for Novelty in the Existing Literature

There are various ways to represent new knowledge, based on the models presented in the literature on organizations. This section introduces two models in which novelty can be traced. They were selected because they are both well known, and they can be adapted to represent novelty clearly.

7.3.1 The NK Fitness Landscape Model

An extremely powerful representation of the search for new knowledge can be provided by the NK fitness landscape model. Despite not being focused on novelty, contributions building on this model have been important for the construction of the discourse on novelty developed in this book. In this Section, the model will be used and interepreted with the primary purpose of developing the concept and understanding of novelty. The NK model was originally conceived in the field of biology by Wright (1932), who mapped an organism's genetic attributes to its fitness levels. In 1993, Kauffman showed that the topology resulting by mapping an organism's genetic attributes to its fitness levels depends on two variables: the number of attributes n, the number of interactions among the attributes, k. When k is zero, the fitness landscape displays a single peak, which is the optimum. When k increases, the landscape becomes rugged and it displays many peaks. Levinthal (1997) introduced the Kauffman model to management, after which he proposed both an illustration and a model of search among decision alternatives, which originally consisted in organizational configurations. Since that

introductory work, the NK model has been used in management and organization studies to investigate organizational design (Levinthal and Warglien 1999), imitation strategy (Rivkin 2000), experiential and cognitive search (Gavetti and Levinthal 2000), product modularity (Ethiraj and Levinthal 2004), product development (Fleming and Sorenson 2004), analogical reasoning (Gavetti et al. 2005), open innovation (Almirall and Casadesus-Masanell 2010) and crowdsourcing (Afuah and Tucci 2012). This book builds on the perspective that interprets the fitness landscape model as a working metaphor of problem solving and knowledge (Gavetti and Levinthal 2000; Gavetti et al. 2005; Afuah and Tucci 2012), with an explicit focus on novelty. Within this interpretation, the dimensions of the landscape serve as a metaphor of the framing of the problem; that is, the points in the landscapes are a metaphor of the solutions of the problem. Thus, possible solutions to a problem are defined by problem explanatory attributes, n, and by their interactions, k. These solutions build a landscape that maps the fitness (performance) of each solution.

This illustration shows the difference between the traditional neoclassical decision maker with full rationality, knowledge of alternatives, consequences, and consistency of its utility function (March and Simon 1958), and the boundedly rational decision maker with limited cognitive abilities, knowledge and time to search for a solution that is satisfycing (Cyert and March 1963; March and Simon 1958; Nelson and Winter 1982; Simon 1955). In fact, while the former can select the optimal solution in a landscape that is associated with the highest peak, the latter does not have visibility of the entire landscape, but can only search in the neighbourhood of his/her initial position. In addition, he/she stops the search when a higher peak in the path is found. In fact, the bounded rationality agent can only make his/her way up the landscape to the nearest peak (Knudsen and Levinthal 2007; Levinthal and Warglien 1999), which may not be the global maximum (see Fig. 7.1 as an example of NK fitness landscape).[2]

As such, this model has been adopted as a metaphor of the search for new knowledge, which is typically local, takes place in the proximity of an established point of entry in the problem landscape, and reflects

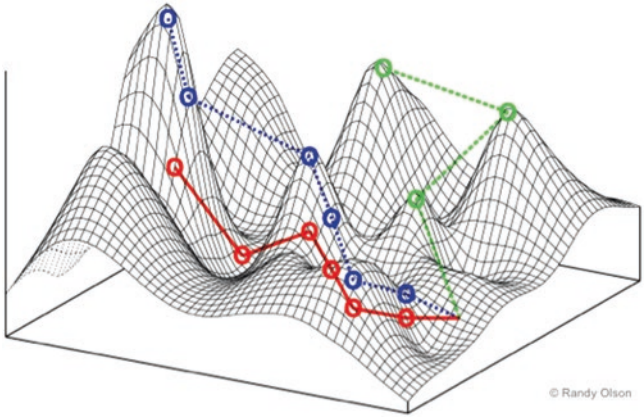

Fig. 7.1 Visualization of a NK fitness landscape. Figure by Randy Olson CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=32274330

what is already known. This model illustrates that the exploration of new knowledge that involves new areas or domains that are unfamiliar to the decision maker can only occur through "jolts" in the landscape; that is, by providing new entry points in the landscape that are disconnected from the knowledge that is already owned. Typical contributions in this line concern the difficulty (in terms of cost, risk and effort) of making such jumps and how organizations make them outside of the metaphor. In this model, this book discusses local and distant searches (through these jolts) by addressing all of the actions that reflect the ideas of exploitation and exploration, respectively, and allow one to acquire local and distant knowledge (Afuah and Tucci 2012) (Fig. 6.4).

In this framework, novelty can occur in two ways: (1) in terms of new solutions within a problem representation that has already been explored; and (2) in terms of a new problem representation; that is, a different NK landscape, where new solutions can be found. In fact, the model illustrates that the difficulty of acquiring new knowledge is due to the difficulty of departing from the established knowledge (which makes a distant search difficult) and the poor understanding of the actual structure of knowledge (both n and k) by bounded rationality agents.

7.3.2 The Socio-Semantic Network Model

A different model that represents knowledge is the socio-semantic network model. A semantic network is a graph structure that represents knowledge in patterns of interconnected nodes and arcs (Sowa 2006). While there are several types of semantic networks, this book considers semantic networks composed of concepts and relationships among concepts. The nature of these relationships can vary from hierarchical to associative. Semantic networks are useful for mapping the grid among concepts in specific areas of knowledge. For example, the semantic network in Fig. 7.2 represents the hierarchical structure of basic concepts that position the concept of "arm" within a closed vocabulary of medicine (Medical Subject Headings [MeSH]).[3] Such networks have been used to speculate on the nature of novelty. For example, they were used to conceive the structure of problem-solving in "Aha! moments" (Schilling 2005).

Frigotto and Riccaboni (2011) adopted an associative semantic network to represent and analyse knowledge. The authors selected the closed scientific area of contributions on Rett Syndrome[4] and mapped the co-occurrence of MeSH terms that, like keywords capturing

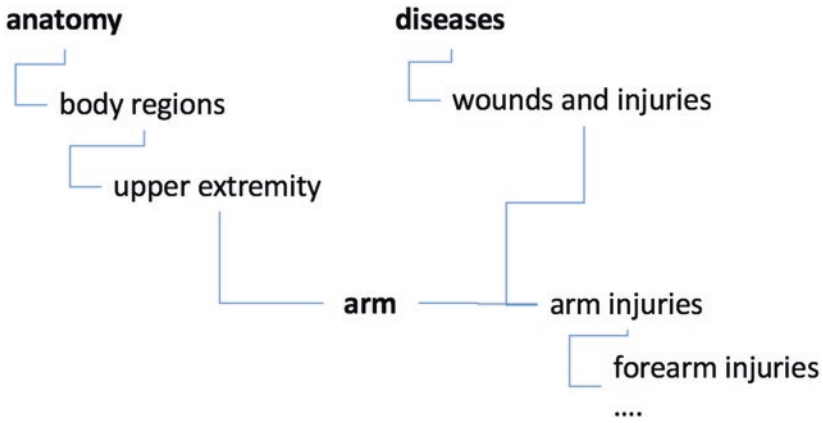

Fig. 7.2 The hierarchical network structure: an extract for the MeSH term "arm"

concepts, were associated with each publication. In semantic networks as such, novelty consists of new concepts and new connections appearing in the semantic network over time. Simplifying this idea to the core, this means that knowledge can be mapped in a matrix where concepts are connected and related to one another as nodes in a network. New knowledge appears in this framework as new concepts and new relationships among the existing concepts or among the new and/or previously known concepts; that is, as changes occurring in the network over time.

This model of knowledge complements the more traditional NK model of knowledge on several aspects. First, in the NK model, novelty consists of new solutions with no specification on their semantic structure. The semantic network allows one to model novelty with a more "fine-grained eye" on its components; that is, new elements or new connections. It also clarifies that novelty consists of (and can be tracked by searching for) new concepts and/or new connections among the concepts, with respect to the state of knowledge. However, it does not convey if such novelties build a complete new solution for a problem (as in the NK landscape) or if they consist of changes along the dimensions that would build the new solution in the NK landscape.

Second, this point builds on the strength of the semantic network, since associative networks do not require one to impose a hierarchical structure on knowledge concepts; that is, distinguishing if one concept belongs to some dimension or another. This allows one to treat empirical data with no need for meta-structures. Conversely, the structure can emerge from the data. Concepts (or edges) are identified as more or less critical in relation to the specific architecture of knowledge—in terms of betweenness, paths between concepts or areas of knowledge. They are not defined logically, but empirically, through the actual connection built by co-occurrence in scientific discourse.

Third, the semantic network can build on real-life empirical data, but it does not mean that it is only a method used to perform research. Conversely, it is also a theory on phenomena (Powell 1990), and as such it also allows one to build the production of data in order to run simulations. For example, this book developed a stochastic model of network

evolution that replicated the topological properties of the networks observed in some real-life cases (Frigotto and Riccaboni 2011).

Fourth, the possibility of building semantic networks on empirical data allows one to study aspects that are not triggered by conceptual intuition, but by the availability of data, which sometimes disrupts the frameworks and allows one to add original results. Among other "sparks", bibliometric data, which allows one to build semantic networks, also allows one to build a corresponding social network of authors that signed publications about the concepts or links in the semantic network. In this social network, the links between authors are built on their co-authorships. The association of the semantic and social networks allows one to study novelty (along the social and semantic realms) and novelty dynamics, as a co-evolution of these realms. This latter point is, per se, not new. The social network, or more broadly, social interaction, has been widely acknowledged as the locus of innovation, and more broadly, of novelty dynamics (Burt 2004; Uzzi and Spiro 2005; Fleming et al. 2007; Padgett and Powell 2012), despite that a clear relationship between position in the network and novelty still requires elaboration and validation (Perry-Smith and Mannucci 2015). However, in several studies, social interaction has been used as an explanation for the dynamics of a context selected on novelty, as a dependent variable. The generation of social networks and semantic networks from the same data allows one to trace the parallel changes in the two realms (Table 7.1) and to identify the co-evolution of novelty. For example, Frigotto and Riccaboni (2011) determined if the introduction of new concepts corresponded to the introduction of new scientists into the scientific community.

Table 7.1 Novelty in socio-semantic networks

	Novelty occurring through:	
	Generation	**Combination**
Generic network	New nodes	New links
Semantic network	New concepts	New combinations of concepts
Social network	New actors (entry)	New collaborations between actors

In principle, it should be possible to imagine a connection between these two representations since there is a connection between the evolution of networks of genotypes, connected via mutational paths, and their performance fitness in Wright's and Kauffman's original models in biology. However, what this connection actually goes through and what it actually means in terms of new knowledge requires further consideration that goes beyond the scope of this book.

7.4 Relativity of Novelty

Having defined novelty as new knowledge, the first necessary specification to give consistency to this definition concerns the relativity of knowledge. In fact, novelty has been defined as the "new" in relation to a point of reference. However, if such reference is not unique, and it varies across different agents, then novelty cannot be uniquely identified with the result that the concept might be ill-defined. More specifically, the relativity of knowledge is twofold:

1. The knowledge of the boundedly rational agent is limited compared to the knowledge of the perfectly rational agent, and what is new to one is not new to the other, who has a perfect and compete overview of the problem and the solutions.
2. Boundedly rational agents are not all the same and knowledge is not homogeneously distributed (Hayek 1937), and what is new to one might not be new to the other, and vice versa.

The concept of bounded rationality is articulated. Bounded rationality implies limits in calculations, solution searches, time and effort in information availability as well as in problem representations that give structure to certain problems. Conversely, the perfectly rational agent chooses the best representations for the problems, the best solution with no constraints in time or energy, and resembles more "a member of Heaven" than a highly gifted human agent, since he/she is considered to be part of a world that offers information with no greediness, and where time has no impact. Despite this richness in theorising rationality, the way in

which bounded and perfect rationality have mainly been understood[5] is in terms of a partial or complete view on available problem solutions, while the issue of problem representation has largely been discarded.

For enriching and strengthening the definition of novelty, there are two different situations in which the relativity of novelty needs to be considered in reference to the fitness landscape metaphor. First, when one problem representation is considered and agents' bounded rationality concerns the limited ability to reach solutions within this problem representation. Second, when more problem representations are acknowledged and agents' bounded rationality concerns the limited ability to move to an alternative problem representation and reach solutions there.

7.4.1 Novelty at the Level of Solutions Within One Problem Representation

In the first situation—within the problem representation—several boundedly rational agents have partial views. Such partial views reflect the background, experience and system of meanings of the agent and the community of people that he/she mainly interacts with in the process. When these elements differ, the bounded views of the agents become contrasted.

In the metaphor of the solution landscape, diverse agents have various entry points, and they oversee different subsets of solutions. Altogether, they build an aggregated and extended set of solutions. The latter might still be a subset of the solutions, which are accessible to the perfectly rational agent. The point in this situation, from the perspective of each agent, is how to reach other diversely bounded rational agents and gain such an aggregated and extended view of the solutions. In Chap. 6 of this book, crowdsourcing serves the same purpose.

In relation to the boundedly rational agent conceived in this manner, the literature has forged the terms of "local search" to address the search for solutions that represent refinements of the present endowment of knowledge and "distant search" to address the search for solutions that require the acquisition of further knowledge. Referring to March's (1991) seminal distinction, local search has been identified with exploitation,

while distant search has been identified with exploration. The interesting point here is that, through the combination of boundedly rational agents, what might derive from a local search for one can be the outcome of a distant search for another, and vice versa. As a result, each agent, by sharing the outcomes of his/her local search with others, can gain an extended perspective on the problem's solutions with less effort than when searching alone. While this concept has been elaborated by Afuah and Tucci (2012), it offers interesting implications for this book's definition of novelty.

Table 7.2 illustrates that the same set of solutions, which would be novel for at least one of the two agents, can result from the local or distant search or, in other terms, from exploitation or exploration. Note that when both agents engage in a local search (Quarter 1) we are not considering the same set of solutions unless the agents are very close to the other; however, in that case those solutions would not be novel to any of them. In fact, novelty is produced in cases of combination of local and distant searches or two distant searches. However, it is reached with different degrees of effort from one or the other agent, and is it is more or less incremental for one than for the other. When novelty is the result of one agent's local search, and the result of at least one agent's distant search that novelty is referred to as *relative novelty*, since, while it

Table 7.2 Relativity of novelty within a known problem representation and agents' strategies

agent *i* | agent *j*	**local search (exploitation)**	**distant search (exploration)**
local search (exploitation)	//	RELATIVE conservative novelty *exploitation + exploration*
distant search (exploration)	RELATIVE conservative novelty *exploration + exploitation*	ABSOLUTE conservative novelty *exploration + exploration*

represents some new knowledge for both, it concerns a greater achievement for one than for the other. Since it takes place within the same problem representation, which is considered established, it is called *relative conservative novelty* (Quarters 2 and 3). Conversely, when, for any agent *i* and *j*, a solution is found that is new for both, and which is, for both, the result of a distant search, then this is an instance of absolute novelty that is called *absolute conservative novelty* (Quarter 4).

7.4.2 Novelty at the Level of Problem Representations

In the second situation—when more than one problem representation is considered—boundedly rational agents develop their solutions within various problem representations. The perfect agent has selected the problem representation that allows him/her to reach a satisficing solution. The perfect agent's representation might be a combination of the dimensions considered by the boundedly rational agents under two circumstances: (1) if boundedly rational agents consider a subset of the right ones or different dimensions; and (2) if boundedly rational agents consider non-critical dimensions.

As an example, Page (2007) provided the humorous example of selecting the automobile with the best gas mileage among those available. In this case, each agent has a perspective into the problem—he/she only understands one variable (the gas mileage variable) and must determine how to rank the automobiles accordingly. As a result, each agent ranks the automobiles according to his/her perspective. For example, a smart actor would consider the automobile's weight, whereas a less smart agent would consider the automobile's color. Then, the agents explore the different solutions or subsets of the solutions, if their perspective provides a partial consideration of the solutions; that is, an agent might only consider electric cars. Furthermore, each agent's landscape maps the miles per gallon based on the only variable, which represents a bounded view of the problem. However, those among these partial views, which are also relevant, map into the "perfect" landscape. This "perfect" landscape includes *n* dimensions, which are the effective explicative variables of gas

mileage. Overall, each agent's models might be mapped onto dispersed solutions in the "perfect" landscape, which has all relevant dimensions.

In this situation, novelty appears at the level of the problem representation (or problem perspective), through the formulation of new ways to conceive the problem which allow to draw a better solution (revolutionary novelty). This novelty is a form of absolute novelty when the problem representation is new to all of the agents. This type of novelty is called *absolute revolutionary novelty*, since it provides a new look into the problem that revolutionises how solutions are formulated, and not only what solutions are targeted, and this new look is new to everybody. Louis Pasteur's theory of germs is an example of *absolute revolutionary novelty*. The previous chapter referred to the strategy of searching for absolute revolutionary novelty through different problem representations as *dimensioning*. Conversely, when the problem representation is new to some agents (but not all). Novelty is called *relative revolutionary novelty*. This pre-paradigmatic novelty represents the outcome of dimensioning for those to which it appears to be completely new, and it represents the outcome of a *versioning* strategy for those to which it appears as a variation from the well-known problem representation.

In sum, at this point, it is possible to identify two dimensions along which novelty can be defined (see Table 7.3). First, novelty can be considered at different levels of analysis—within an organizational member,

Table 7.3 Relativity of novelty within known and new problem representations and agents' strategies

	new solution in known problem representation	new solution in new problem representation
NEW TO SOME	RELATIVE conservative novelty *exploitation + exploration*	RELATIVE **revolutionary** novelty *versioning + dimensioning*
NEW TO ALL	ABSOLUTE conservative novelty *exploration*	ABSOLUTE **revolutionary** novelty *dimensioning*

within an organization, within a set of organizations or in the entire system of organizations. In relation to such levels of analysis, *relative* novelty concerns what is new for one or some elements in a system, and *absolute* novelty concerns what is new to the entire system. Between these two polarities, some authors (Fleming et al. 2007; Frigotto and Riccaboni 2011) proposed a continuous measure of novelty that is inversely proportional to diffusion.[6]

Second, novelty can be traced along two dimensions of knowledge: solutions and problem representations. When it appears at the level of solutions within a unique problem representation, novelty is *conservative*, as it is conservative of the established problem representation. Then, it might be relative or absolute, depending on whether the element of novelty is already known among some agents. When it appears at the level of problem representations (and consequently, of the solutions that are reached within it), novelty is *revolutionary*, as it has the potential of disrupting established knowledge, and it might appear as a revolutionary threat. Then, it is relative when agents refer to the competing problem representations (as a type of pre-paradigmatic situation) or absolute when all agents have converged to one problem representation and the new one is new to all of them.

7.5 Impact

Typically, the primary way to understand a phenomenon is through the definition of its ontological properties. In the case of novelty, this approach would imply discriminating what is new from what is already known. However, as claimed in several parts of this book, such a distinction is not always easy to make. As the philosopher of science Massimo Pigliucci stressed (2008), the necessary reference point for understanding what is new is to understand its "sameness", and unfortunately, this is not an easier task.

To define novelty only on its ontological difference from what existed earlier would be to ignore that novelty, is in most cases, negligible. Indeed, it would be desirable to associate a value according to the ontological properties of the new, so that it would be easier to

predict its impact and select the novelty accordingly. However, in the present state, we do not know the dynamics of novelty evolution well enough to be able to elaborate on such evolution. Then, the issue is not to assess whether or to what degree novelty embeds the old elements, since this would not make an impact. Instead, the way to reason upon it is to ask what it is potentially possible with the novelty, especially in terms of what further paths of knowledge creation can be followed. The existence of this potential does not mean that it will occur or that the actual performance of novelty will effectively express all of its potential. Rather, this impact measure could be seen as an option embedded in novelty that can provide a maximum payoff (if adequately developed), but whose actual value can be less or equal to this payoff.

The concepts of conservative or revolutionary novelty reflect this idea. Revolutionary novelty opens to an entire new space of solutions where new peaks can be found. However, whether this set of solutions will allow one to reach better performances depends on the specific case. Conservative novelty has a lower potential since it concerns the identification of fewer solutions. However, it takes place in a problem representation that is already known and where conservative novelty can be targeted in the presence of more background knowledge.

The evaluation of the impact of novelty also requires the consideration of how many people[7] would see the novelty as something new. Similar arguments apply to this aspect, as those concerning the problem representation where novelty occurs. While it is possible to elaborate this concept within the landscape metaphor, it could be tested through simulations, since the network model of knowledge allows one to build on empirical data; that is, from scientific publications. Let us compare two semantic networks referring to the state of knowledge on Rett Syndrome, which is a rare disease[8] (Fig. 7.3). The Network A maps the co-occurrence of keywords[9] in the publications on Rett Syndrome between 1989 and 1999, while in Network B, such occurrences appeared from 2000 to 2011. These two periods are built around the discovery of the cause of Rett Syndrome in 1999, which identified that mutations in the MeCP2 protein are responsible for the appearance of the syndrome. If we observe the network before 2000, then the

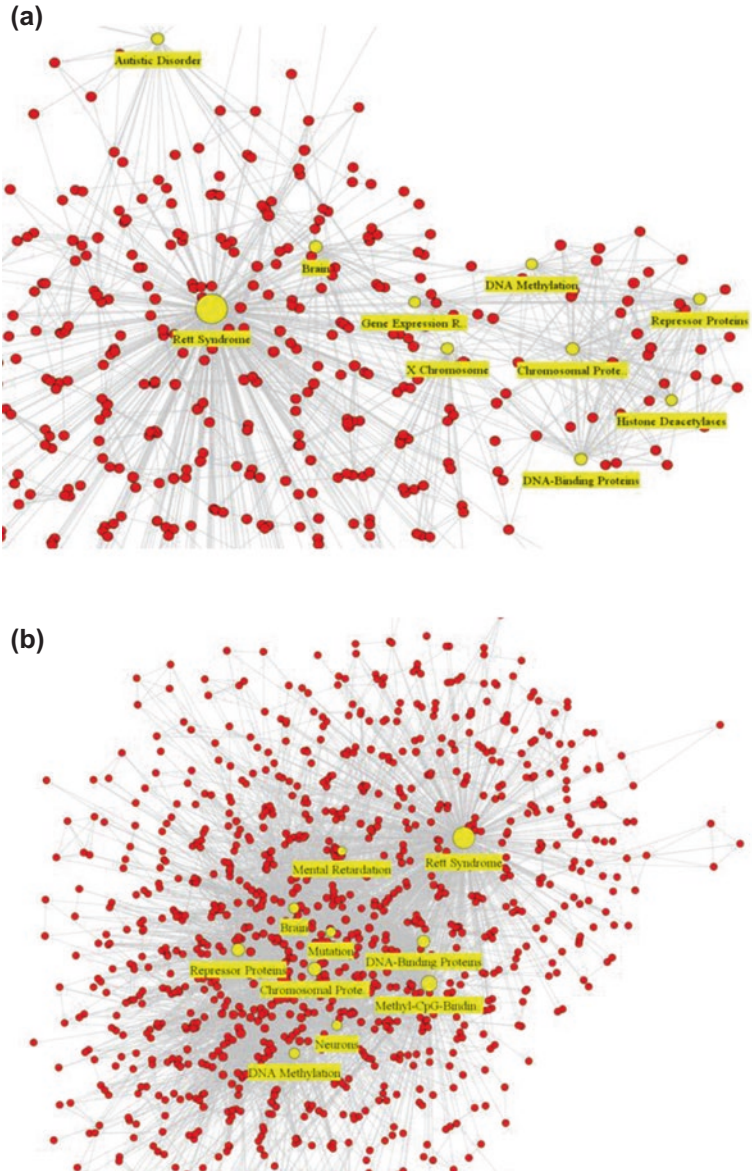

Fig. 7.3 The semantic networks on Rett Syndrome.[11] (a) Co-occurrence of concepts in the literature of the 1989–1999 period (b) Co-occurrence of concepts in the literature of the 2000–2011 period

"methyl CpG Binding Protein 2" or "MeCP2" concepts are not present, whereas after 2000, they become the second most prominent concepts in Rett Syndrome semantic network.[10] Conversely, concepts such as "X Chromosome" and "Autistic Disorder" are no longer in the top 10 concepts after 2000. In sum, the novelty expressed in the relationship between MeCP2 and Rett Syndrome was impactful since the network of knowledge regarding the disease significantly changed after its introduction.

Within this framework, novelty that has a significant impact refers to new concepts (nodes) or new connections (edges) in the knowledge matrix that produce greater changes on the entire network. This means the following: (a) the new concepts (or sets of concepts) are added; (b) they are substitute concept(s) in the network; (c) new links are added; (d) new links are removed; or (e) all of the above occur simultaneously. For instance, new links might introduce the connection of previously isolated concepts or indicate that the heavy modification (additions and cancelations) of concepts in the network might imply the modification of the architecture of knowledge (connections). Regarding the knowledge on Rett Syndrome, the discovery of MeCP2 in 2000 stimulated research and the investigation of the relationship between MeCP2 and other concepts that were not included in earlier research on the disease (the number of distinct concepts changed from 438 to 1077). To stylise this point in a simple network, consider Fig. 7.4. The novelty provided by the new concept that appeared in Network B is more impactful than

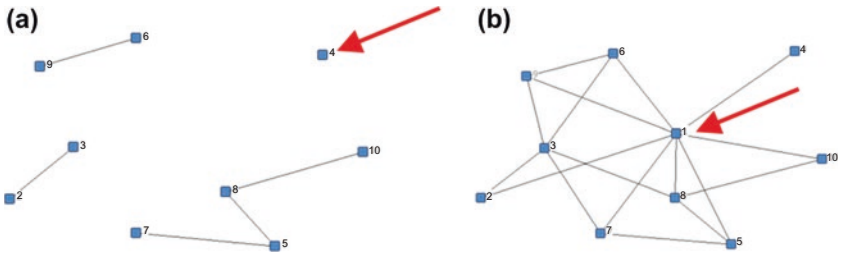

Fig. 7.4 Examples of the different impact of novelty in simple networks

that offered in Network A, since the new node in Network B links the nodes that would be otherwise separated.

7.6 Awareness: Designed and Emergent Novelty

The previous sections specified the types and models of novelty, showing that novelty is an articulated concept (as well as a multi-faceted phenomenon). While they sketched the strategies for reaching the novelty types, it does not mean that organizations will effectively engage in such ventures. As a matter of fact, a further element to consider is the awareness of novelty. Based on Abbott's 1884 allegorical tale, Adner and Levinthal (2008) illustrated that, as "flatlanders"; that is, inhabitants of a two-dimensional space, we are not aware or unable to understand the existence of the third dimension. In fact, people hardly focus on this line of thinking since it is unconceivable and invisible to them.

In models of novelty, there are several ways to represent novelty that remains "uncovered". In networks, it could be modelled in terms of a smaller network with respect to a completely aware network of knowledge. In the NK model, it would consist of the areas that are not overseen or searched by any agent, neither within the usual problem representation nor within others. Novelty remains "uncovered" as a result of three main cases: (1) Some areas of knowledge are researched, but knowledge is difficult and it takes time to be defined (i.e., areas are researched, but are waiting to be filled with some knowledge); (2) Some areas of knowledge are not researched since organizations deliberately decide to do so; and (3) Some areas of potential novelty are not researched since they are unknown or unimagined (i.e., the knowledge network is not completely visible, but it must discovered through research).

The analysis of the areas of the unknown is important for capturing the different attitudes that organizations may have towards them as well as to assess the search difficulty. Concerning the first case, organizations clearly know they need to search for new knowledge, but they

have difficulties in understanding how to define the problem and how to search for solutions. In the second case, organizations do not do anything since they might strategically consider the area too costly, too risky or simply non-interesting for the potential returns. For example, rare diseases typically fall into this category, since they concern too few patients for justifying expensive research investments. The same outcome is associated with the third case, but with the difference that inactivity is due to ignorance and not choice.

Several authors have worked on new models of decision making, accounting for ignorance (e.g., Feduzi and Runde 2014; Frigotto and Rossi 2015). In organization studies, Roberts (2012) proposed a reflection on individual or organizational ignorance. A common basis among contributions on the topic is a direct (or indirect) reference to the categories Donald Rumsfeld created in 2002 in his testimony on the Iraqi "weapons of mass destruction". He talked about them as concerning the "unknown unknowns"; that is, something that is not known since it is beyond imagination, and not considered or worth considering possible.[12]

Through such reflection, the discourse on established knowledge and new knowledge is extended to include a consideration on the awareness of what is known and what is not known, which is where novelty appears. In order to structure this extension, it is useful to build a framework in which we distinguish between the awareness on what is known anowledge.

According to the matrix Table 7.4, Quarter 1 represents the *known known*; that is, the state of knowledge or with reference to one

Table 7.4 Designed and emergent novelty

		Knowledge	
		known	unknown
Awareness on what is known/unknown	known	1 present memory	2 structured ignorance **DESIGNED NOVELTY** (targeted or discarded)
	unknown	4 blurring memory **REVIVING NOVELTY**	3 blissed ignorance **EMERGENT NOVELTY** (serendipitous innovation new emergencies)

organization in particular, what the organization is aware of knowing. The overseen landscape in the NK landscape fits this quarter.

Quarter 2 represents the *known unknown*, meaning the areas in which novelty is expected to appear and is often targeted to appear. Novelty in this quarter is the *designed novelty*. These are areas in which novelty typically occurs through either a local or distant search, but always within a conservative problem representation. Conservative novelty illustrates this case. The vast majority of scientific research has addressed *known unknowns* (Logan 2009). In other words, scientists develop a hypothesis to be tested, and while the researcher does not know whether the results will support the null hypothesis, it is common for the researcher to believe that the result will be within a range of known possibilities.

Quarter 3 represents the *unknown unknown*—areas whose existence is ignored. Here, the attitude is *not* to perform research to fill these gaps. These areas represent novelty that derives from dimensioning; that is, from the access to knowledge that is as distant to what is known as the space dimension to "flatlanders". In this sense, it represents *blissful ignorance*—the status of ignorance that is unaware and thus does not trigger any resolution. Novelty deriving from this quarter is *emergent novelty* and the way in which it typically appears without having been pursued is through unexpected results within investigations of the *known unknown* or through serendipity. In the field of aerospace engineering, the *unk unks* refer to this type of knowledge, which has not been and could not have been imagined or anticipated (Roberts 2012; Mullins 2007). High-risk research often finds results that are positioned in this quarter. Serendipitous innovations are also positioned in this quarter as well as new emergencies.

Finally, Quarter 4 represents the *unknown known* concerning knowledge that is potentially available but is unknown due to memory flaws—it has been forgotten. This quarter represents the relativity of knowledge with respect to time, as knowledge is subject to limited storage capacity and users' attention while novelty is also referred to time. What belongs to this quarter is *reviving novelty*. In fact, individuals and organizations generally focus on some issues while neglecting others. Such focus reflects vividness, meaning how much an issue is striking

and remains distinct in the present discourse (Shedler and Manis 1986). It also reflects recency—the proximity in the time of use of such knowledge; that is, issues that have been raised more recently are better known than those from back in time.

While this book associated *designed novelty* to *conservative novelty* and *emergent novelty* to *revolutionary novelty*, this association is not exclusive. Research on open innovation and crowdsourcing discussed in Chap. 6 has shown that search strategies in which the structuring of the problem is entrusted to solvers, rather than designed by those who post the call for solutions, has proven to be effective at targeting revolutionary novelty. Rather than through control on the problem definition, this outcome is a result of the definition of open questions and the involvement of solution providers. Within the context of emergencies, strategies deployed to learn from new emergencies also have this purpose.

7.7 Dimensions and Measures of Novelty

This chapter has defined novelty along three main dimensions. First, novelty is conservative or revolutionary, depending on whether it occurs within the established problem representation or it is conveyed by a new problem representation. Such a distinction is relevant with respect to two variables: the effort required to find such a novelty as well as what the potential novelty can reveal. In fact, the agent faces the difficulty of pursuing an actual search strategy, especially when it departs from the usual problem representation. Furthermore, this dimension needs to be revised in order to incorporate agents' awareness of the novelty that can be targeted or considered. When novelty does not lie within the agents' awareness area, it is very unlikely that it will be uncovered. Thus, when this occasionally occurs, the novelty is potentially disruptive.

Second, novelty is relative or absolute, depending on whether it is new to all of the agents or to a subset of them. It is also possible to make this dimension continuous as, for example, when it becomes the inverse of diffusion (Fleming et al. 2007; Frigotto and Riccaboni 2011). Third, not every novelty is relevant and the contrary is most likely.

Novelty is impactful or negligible, depending on whether it triggers a large or small change in performance or in making the further development of novelties possible.

In order to provide a representation that respects the dynamics of novelty along these dimensions, this section will consider the multidimensional space defined by all of the relevant explanatory dimensions of a problem and the measure of performance of each solution. To make it more general, consider that non-relevant dimensions are also included but are associated with zero performance. This multidimensional space hosts the complete and perfect representation of the problem, or to simplify, we could say that this is "the truth". Through this starting point, let us adopt a realist approach to the ontology of knowledge, as something that exists out there and to which humans can attempt to seize. At this stage, the idea that knowledge is instead a construction of human agents that evolves with them is too difficult to be elaborated. This is "the truth" representation, rather than the representation of the perfectly rational agent since it is also free from the limits that do not reside in the agent, but derive from the context. In addition, there is the imperfect availability of information that is not given (but needs to be searched) and not reachable (but typically unfolds over time) through the process of discovery.

In this framework, boundedly rational agents have a representation of into the problem, which is a subset of "true problem representation".[13] Agents' representations might also include dimensions, which, in some time in history are considered to play a role, but in the true representation, are non-relevant (see irrelevant dimensions in Fig. 7.5). Agents can search for solutions within their problem representation in time *t* or they can search for other problem representations where they can obtain other solutions.

A further restriction concerns the fact that agents are unaware of the entire landscape of solutions in their problem representation and are even unaware of all of the problem representations that might be built, since they only see some problem representations. As a result, they target solutions that belong to the areas that they "can see" (i.e., are aware of). Through this limitation, this book included the awareness dimension.

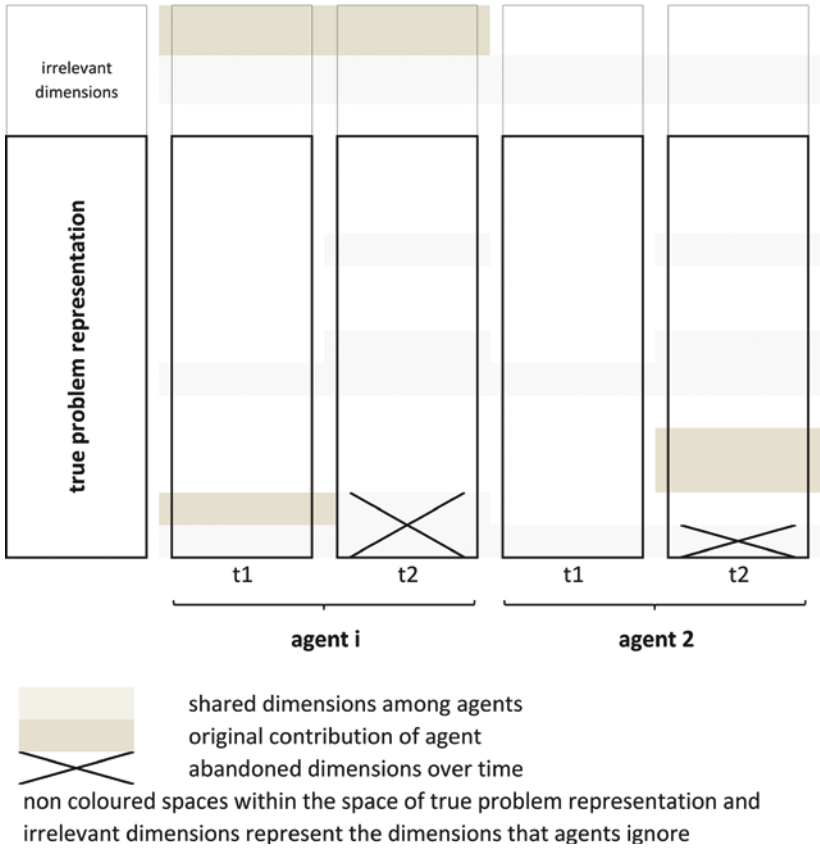

Fig. 7.5 True vs. bounded problem representations

It is possible to map conservative and revolutionary novelty (see Fig. 7.6), which represent, respectively, a new solution within the usual landscape or a new solution within a new landscape. Such representation can be interpreted as that of one agent or of a set of agents. A measure of the distance of novelty can be given by the Euclidean distance between the starting point and the novel point measured in the true space where all dimensions are included and a measure across the limited landscapes of the agent can be computed. Such measure can be adjusted to reflect difficulty. It should be the maximum when all of the agents have the same starting landscape and the new landscape is

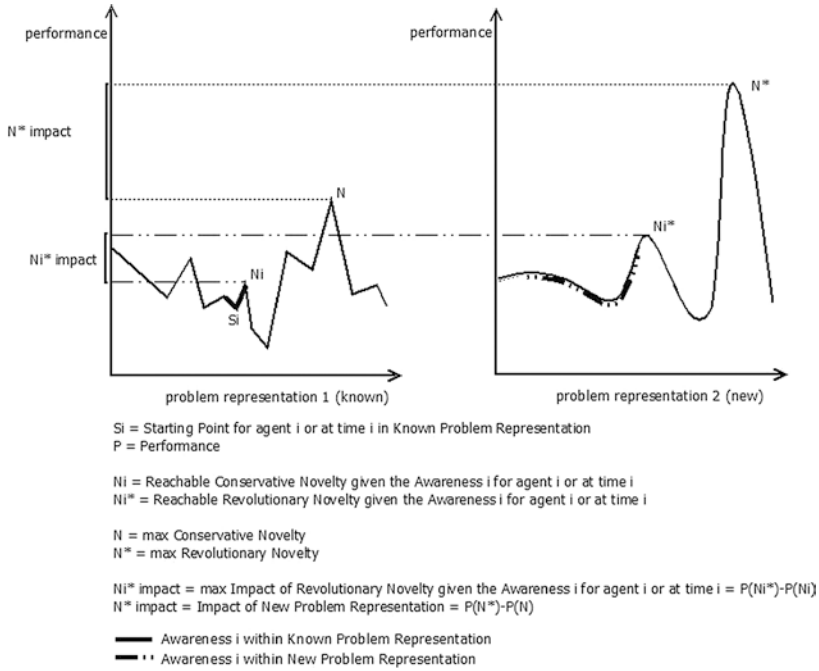

Fig. 7.6 Revolutionary novelty impact and awareness

new to everyone, while it should be discounted by a proportion of the agents that already own the new landscape. A further element increasing this measure would be awareness so that, if the new solution does not belong to the area of awareness of the agent(s), then the distance is increased by factor *a*.

This measure only provides a rough representation of the difficulty for an agent to reach a novel solution. In general, from the analysis of moves within one problem representation, it is known that distant solutions require "jolts" that are particularly difficult when landscapes are rugged (meaning when one cannot explain the problem with the selected dimensions). However, when we add the possibility of changing the problem representation, while the distance allows one to measure how far or how close the two solutions are, the effective difficulty for the agent to reach the solution depends on how hard it will be

for the agents to move to the new dimension(s). In other words, the question concerns what constitutes the connection between the initial and the novel representations. For example, the agents could follow a path through the exploration of the landscape built by the interaction between the first space and the space built on the new dimensions (see Fig. 7.7). In such a case, the landscape ruggedness would play a considerable role. However, other ways could be possible, such as jumps from one representation to another, which could, for example, represent the "Aha! moment" (Schilling 2005). Page (2007) solved this issue by assigning diverse representations to various agents and by imposing sequential interaction among them. While fundamental to understanding the difficulty of novelty across problem representations, further thoughts are necessary to understand how to model the link between different problem representations. Moreover, the analysis of solutions could probably imply the adoption of a simulation model and other methods of investigation, which go beyond the scope of this book.

The final dimension to consider is impact. To keep things simple, it is possible to define impact for boundedly rational agents at some time *i*. This restriction is necessary since novelty's impact might change over time. In addition, a novelty that does not appear to provide a significant impact can reveal it in later times, as a result of new agents joining the search and the development of greater awareness or different search strategies. Correspondingly, there is a maximum novelty impact, which might never be reachable given a certain level of awareness; awareness is related to the state of knowledge of the agent or of all agents in some

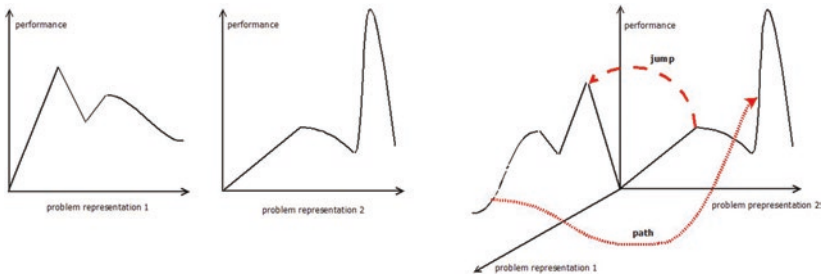

Fig. 7.7 Path or jump for novelty detection

time period (for example, without jumps, an agent in Si will never be able to reach max N in Fig. 7.6). The impact of conservative novelty for agent i or for the system at time *i* can be considered the difference between the maximum performance value, which is reachable given a certain awareness *i*, and the starting point (P(Ni)-P(Si) in Fig. 7.6). Similarly, given the awareness *i,* the impact of revolutionary novelty with respect to conservative novelty can be P(Ni*)-P(Ni). Meanwhile, the maximum impact of revolutionary novelty (i.e. of a new problem representation) is given by the difference between the maximum performance within the new and the starting problem representation (N* impact). This latter impact refers to a kind of novelty which is absolute, when *i* represents a time period of the system, in which all agents share the same awareness *i*. Finally, the novelty impact of two solutions (for example Si and Si') within the same aware problem representation is given by the performance difference of the two solutions.

Notes

1. Rosenkopf and McGrath (2011) referred to mechanisms or processes (p. 1302) that "provide[s]or demonstrate[s] exposure to new knowledge".
2. Bjorn Østman and Randy Olson, "Using Fitness Landscapes to Visualize Evolution in Action," 2014 Online available at URL: https://en.wikipedia.org/wiki/File:Visualization_of_a_population_evolving_in_a_static_fitness_landscape.gif.
3. The MeSH is a closed and hierarchical vocabulary of medical topics, which are defined and updated by the U.S. National Library of Medicine. The purpose is to identify content with little risk of dispersion, due to the use of synonyms or alternative formulations of the same concept. They are also used to categorise contributions with little to no risk of loss of meaning.
4. See Footnote 31 in Chap. 5 for a brief description of Rett Syndrome.
5. While original formulations of bounded rationality by the Carnegie School made this clear (e.g., March and Simon 1958; Cyert and March 1963), there is a difference in the way the Carnegie theories have been understood, especially in economics and economic decision making.

6. This book will return to this point in the final section, which discusses the thorny issue of the distinction between the old and the new, and proposes that it can be assessed by measuring the impact of novelty on what existed earlier.
7. More precisely, the argument should not consider the absolute number of people, which is not relevant per se, but the relative number in relation to a relevant population.
8. See Chap. 6 for an explanation of Rett Syndrome.
9. The special keywords adopted to classify scientific work in medicine are the Medical Subject Heading (MeSH) terms.
10. This is measured in terms of frequency in the occurrence of the "methyl CpG Binding Protein 2" or "MeCP2" in the MeSH publication.
11. These networks were presented at "Sunbelt XXXII": INSNA: International Network for Social Network Analysis, 14–18, March 2012, Redondo Beach, CA, by M. Laura Frigotto, Gianna Giudicati, Jenny Johansson, Katarina Larsen, Massimo Riccaboni, Nandini Roi, "Prizes as Breakthrough Innovators: In Search for Patterns of Emergence."
12. In February 2002, Donald Rumsfeld, who was the U.S. Secretary of Defense at the time, was asked about the lack of evidence linking the government of Iraq with the supply of weapons of mass destruction to terrorist groups. He stated, "Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns. There are things we know that we know. There are known unknowns. That is to say, there are things that we now know we don't know. But there are also unknown unknowns. There are things we do not know we don't know." http://www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=2636, last visited 4 November 2014.
13. The same modelisation of boundedly rationality agents is in Gavetti and Levinthal (2000).

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8

Organizational Implications and Conclusions

In this book, the concept of novelty has been constructed across the negative and positive domains of consequences. As a result, novelty is defined as new knowledge that is provided, required or demonstrated in various manifestations; for example, in new technologies, new problems (e.g., new emergencies), and new products and that is in relation to a population ("WHO") and to state-of-the-art knowledge ("WHAT"), as follows:

- "WHO"—novelty is a relative concept, so some knowledge can sound new to some and old to others. Novelty can be considered in this way only if it has knowledge that is new at least to someone. Then, it is articulated into *absolute* and *relative* novelty when it concerns everybody or some people only.
- "WHAT"—novelty may concern large or small changes of extant knowledge, so novelty may vary from *conservative* to *revolutionary*, respectively, when it enriches state-of-the-art knowledge (or known problem representations) or when it disrupts it and brings about a new knowledge perspective (or new problem representation).

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Novelty may appear to be an ingredient or outcome in a process of novelty generation, or more broadly, in a process of change. Novelty is not always useful, nor is it always impactful. Most novelties are, in fact, negligible. However, novelties providing an impact are phenomena that organizations typically want to act on (produce or avoid). In other words, organizations target novelties that have a great impact because they want to produce a novelty that is successful and want to avoid a novelty that is a failure. The problem is that the novelty organizations conceive and act on is limited because their capacity to imagine and target novelty is limited. Most novelties are emergent novelties, consisting of new knowledge, and these novelties are ones that have never been pursued; as a result, most novelties cannot be targeted nor designed. As explained in Chap. 2, emergent novelty might be derived from incomplete knowledge within a determined world, from a hidden order that must be uncovered, or from transformative knowledge within an undetermined reality, where novelty is not predefined from what is not known but is formed through interaction.

Here, it seems that organizations target only a small set of the novelty phenomenon, as the set of novelties organizations can design, meaning they can conceive and imagine, is limited and there is no particular reason to claim that their selection included the most impactful cases. Although many novelties have less of an impact, an expansion of the considered set of novelties would increase the possibility that an emergent revolutionary novelty is found and acted upon. Indeed, this expansion is potentially explosive in terms of costs and risk because it is costly and risky to move from a local to distant search. For this reason, it is necessary to adopt strategies that can both expand on the set of novelties and keep costs and risks under control.

But can such theoretical elaboration be relevant to the world, besides in the realm of speculative curiosity and logical exercises? First of all, does the explanatory power offered by the conceptualization of novelty allow one to better understand the phenomena in the world?

Consider the following two cases:

1. In 2007, network scientist László Barabási (2007) published an article in the *New England Journal of Medicine* claiming that medical research

and practice is organ based. Our current knowledge and education is organized around specific organs, so we have neurology and neurologists, cardiology and cardiologists, and so on. This organization of knowledge is also reflected in the organization of rooms in hospitals (i.e., in the aggregation and separation of doctors and patients), so we have the department of neurology, of cardiology, and so on or specific hospitals dedicated to these single areas. So there are brain, heart or lung diseases that are cured by neurologists, cardiologists and lung specialists. However, research on genes and cells has shown that the structure and the dynamics of the human body are oblivious to the final form of the different organs. The evidence is that apparently, unrelated diseases are not independent from each other because they share one or some genes. Therefore, our way of categorising them into different diseases that are then researched, addressed and cured independently is deeply wrong. In fact, each cellular function and its dysfunction (appearing in diseases) can be accounted to a specific network module consisting of genes and their dynamic links.[1]

If this is true, and several advancements are reported when this perspective has been adopted, medicine will become a science of networks and network dynamics; medical knowledge will be refocused around the idea that the structure and dynamics of the human body is constituted by the genes and their links; education and hospitals will be reorganised, hopefully bringing about better cures for human diseases.[2]

2. In the last few months, between 2015 and 2016, Europe has been struck by an insistent series of terrorist attacks. On November 13, 2015, in Paris, a mass shooting occurred, hostages were taken at the Bataclan theatre during a concert, and three suicide bombers blew up themselves outside the Stade de France during a broadcasted football match, which was attended by the president of France; several mass shootings and a suicide bombing at cafés and restaurants followed. On March 22, 2016, in Brussels, three coordinated suicide bombings occurred between 8 and 9 am when people usually are travelling to or for work. On July 14, 2016, France's National Day, in Nice, a truck plowed into a crowd waiting for the fireworks on the Promenade des Anglais. On July 22, 2016, in Munich, an

18-year-old German and Iranian citizen shot into a crowd at one of the major malls. On July 26, 2016, in France, two men slit an old priest's throat while he was celebrating the early morning Mass and took five people hostage. On December 18, 2016, in Berlin, a terrorist drove a truck into the crowds at the Christmas market in City West. In the media and in political discourse, terrorism is increasing as a central topic because people are developing a perspective on the probability of life and death in normal life, one that is radically different from times in which terrorist attacks were something that typically concerned countries in other continents. If these attacks were in Europe, they used to only be in small and clearly identified regions such as Northern Ireland, the Basque Country, or South Tyrol. The terrorist attack in Madrid in 2004 spoiled this perspective but did not have a great impact until it remained isolated. In the last year, people in Europe internalised terrorist attacks as a possibility, where apparently normal people with whom we share the metro, a tradition or a music performance can become killers. Some say there is a certain form of collective psychosis developing within the European population (Renard 2016). Surely, it is possible to claim that people have reset their map of risks upon a new perspective, which is "the new normal," as claimed by *The Economist*. This new normal is where "big cities in Europe and America will have to get used to a long campaign of terror in which all are targets."[3] This new feeling was well expressed in the James Bond movie *Skyfall* by the Director of the Secret Intelligence Service: "Enemies are no longer known to us. They do not exist on a map. They're not nations, they're individuals."

Before a perspective on novelty, it must be noted that these two cases did not have anything in common. In fact, they display the same kind of transformation of a reference system, from medicine built around organs to a medicine built around networks of genes; from wars fought by the military against clearly identified enemies and in delimited war zones to threats that may take place anywhere; from enemies that look like friends and that are directed to people who are not soldiers. Although these two cases reflect very different classes of events, which each have specificities, the possibility to put them together under

the concept of novelty allows one to grasp their similar nature and to understand them as revolutionary novelties. The possibility to analyse their nature and dynamics across differences and under revolutionary novelties allows one to gather a better understanding of a single phenomena, as well.

The availability of a concept that encompasses the transformations illustrated in the two cases provides advancement in our understanding of how novelty appears. In fact, although one could argue that we could call the transformation of medicine a scientific breakthrough, this would tell us nothing about the nature of this change; it would just measure its potential impact. Although this is parsimonious when we focus on the effects (as the concept of innovation invites us to do), it is not helpful when we adopt the ex-ante perspective of when the innovation is to be generated. The concept of novelty allows us to clarify the nature of an innovation or a scientific breakthrough, like in the case of network medicine, and to assess the potential impact before it has taken place. Moreover, the adoption of the concept of novelty to understand phenomena allows us to define a direction along which novelty is being generated and the criticalities that are associated with that path. Although this book is far from offering definitive answers, the analysis of organizational experiences dealing with both innovation and new emergencies under the perspective of novelty can help create some tentative pillars for organizational strategies and implications regarding adequate structures and competencies for pursuing novelty.

Actually, a second question that would provide empirical relevance to the perspective on novelty is the following: Can thinking about novelty help us understand and identify the direction to take to pursue it? Remember that the concept of novelty articulated in this book is comprised of revolutionary and conservative novelty. This question is particularly interesting when referring to revolutionary novelty because this novelty type introduces not only different solutions within an established understanding but also a different perspective and a different understanding of problems (different problem representations) that also provide different solutions. The experience of emergency management organizations discussed in this book has shown that revolutionary novelties, such as new emergencies, are often difficult to anticipate because

people struggle with imagining them. New emergencies are, in fact, emergencies that cannot be included among standards or among previously occurring cases in an ex-post perspective. In an ex-ante perspective, they belong to the area of the "unknown-unknown" because their occurrence and their form are so new that they could not be imagined. As such, when they actually take place, they appear as emergent novelties. A similar point can be made building on the discourse on serendipitous innovations; serendipitous innovations are, in fact, novelties that have not been conceived in those terms (e.g., as a combination of apparently unrelated elements, for example, the radar waves and cooking, or a car driver's safety and torpedoes).[4] Although serendipitous innovations are novelties that have been found without being targeted and pursued, it is reasonable to claim that they are instances of a larger category of novelties that are not targeted and are also not found and that complete the broader set of the "unknown-unknown".

In particular, for being able to see emergent novelty, our question on relevance would turn into a kind of paradox: How can emergent novelty be targeted if it is not part of our awareness and knowledge? How can it become part of our imagination? To unravel this paradox, it would be necessary to transform emergent novelty into one that is targeted and somehow designed and controlled. The word *somehow* is necessary because this transformation requires that we restate what we mean for design and control. In fact, the concept of control is tailored on the situation in which novelty is limited to the uncovering of new solutions that are expected within an established framework of understanding (designed conservative novelty); in this situation, control is concerned with the definition of the general framework of the project, on the actions required and on the contributors. In Chap. 6, this situation was exemplified to an extreme in the case of a well-structured problem where more workforce could provide the expected solutions (the 500-calorie meal situation). This does not mean that novelty in this case is trivial because it can consist of difficult solutions. However, when emergent novelty is concerned, control and design have more to do with triggering the formulation of alternative perspectives on the problem rather than defining and targeting one or a set of solutions within one particular perspective. As a matter of fact, the design of an emergent novelty is

possible only in abstract terms (i.e., a solution based on a different problem representation); however, the actual outcome cannot be designed in detail because the alternative problem representation has yet to be formulated and the solution to be imagined. Depending on the causal frameworks discussed in Chap. 2, this incompleteness can be considered either the result of ignorance in a determined world because neither individuals nor organizations have a complete knowledge and struggle to unveil the so-called hidden order, or it is the result of continuous formation towards an undetermined form in an undetermined world.[5]

In answering the question of practical relevance, it is possible to identify two alternative strategy sets whose difference lays in considering the relative property of novelty: "WHO" perceives novelty and who does not. These sets were identified by a process of reframing the solutions suggested in Chaps. 5 and 6, respectively, on black and white novelties that come under a unifying perspective on novelty. Specific references to the studies mentioned in the following part can be found there.

The first strategy set ignores the relative property of novelty and focuses on how to produce a revolutionary novelty (the "WHAT"). The assumption is that relativity is zero and revolutionary novelty is absolute, meaning that it is new to everybody. The generation of revolutionary novelty has to do with *dimensioning*, defined as the strategy that allows one to reach new solutions through the reformulation of the problem into a new problem representation that displays different explanatory dimensions.

One way of supporting dimensioning is by contrasting a focus on efficiency. Dimensioning requires resources but cannot guarantee success; a logic of efficiency hinders dimensioning and any form of novelty that is not designed ex-ante. Similarly, various forms of perpetuation of consolidated successful experiences will kill novelty. For example, consider core rigidities and cognitive entrenchment that fall under the technological, managerial and cognitive specialties of an organization: they allow organizations to successfully manage repetitive tasks because they build on an organization's cumulated experience; however, they hamper novelty because they halt the formation of alternative perspectives on problems, which are usually considered impossible or inferior to the way things are done. Novelty requires time and effort; there must

be a discussion about how best to challenge the usual problem representations and how to attempt alternative solutions. An important step here can be building awareness of this natural tendency of killing novelty and creating structured processes that deliberately challenge it. More precisely, positions that are typically taken for granted should be discussed by asking how the problem has been constructed, how it has found expression in some questions, how the availability of solutions has impacted on the formulation of problems, and how the use of language and the succession of information has led to a certain framing of the problem and anchoring of solution search. In general, these points suggest that it is important to build competencies that allow one to flee the typical cognitive traps and search for alternative perspectives.

When a lack of time hampers the questioning of problem representations which typically happens in high-reliability organizations (HROs), it is necessary to discuss problem representations within a scaffolding structure that buys time and attention for the discussion. In emergency situations where quick responses are necessary, HROs turn to both the mini-second and the many-second coordination cycles, where they perform a general but immediate response (mini-second cycle) that allows them to gain time for questioning the problem representation, hence producing a more specific and effective response later on (many-second cycle).

However, it is also important to act on the structure of the organization. Again HROs showed that fluid (or unspecified) structures are crucial when attempting to avoid the entrenchment of competencies in organizational areas (e.g., divisions). In fact, divisions represent competencies that are relevant within a certain problem representation; thus, it is very hard to discuss that problem representation because it is embedded not only in people's minds and actions but also in their identities. For example, cardiologists are not just doctors of the heart; they belong to the cardiology department, they specialised in cardiology with some other cardiologists, and they are different from other specialty doctors. If we say that medicine is no longer organ based but rather network based, who do cardiologists become? It is not only hard for them to think in a different way, but a different perspective would also steal away their identities, and as a result, their resistance to novelty would

be stronger. Moreover, a structural separation of knowledge within the organization also hampers the combination of such knowledge. If division A is concerned with certain competencies and certain solutions, then it will be difficult to combine them when responding to a problem that is typically under division B. Furthermore, structural considerations should also be drawn on roles. As discussed in Chap. 6, studies on innovation showed that novelty cannot be easily recognised by managers who deal with implementation and performance; conversely, it is more likely recognised by people who are engaged in creating it. For example, in the circus, artists present their new acts at auditions; after the auditions, managers decide what new acts to put on stage. However, artists are better than managers at recognising new acts that might be acknowledged by the public.

Although these strategies support divergent representations and novelty, they do not ensure that they will eventually be produced and that emergent novelty will be seized. A different approach is undertaken in drug discovery, which is based on a brute-force principle. In contemporary drug discovery, collections of differing compounds, called chemical libraries, are synthetically produced. Because many molecular interactions cannot be predicted, chemical libraries are matched with several biological targets to search for a "hit", (i.e., a chemical with an appropriate interaction with a biological target that might be developed into a drug). In this phase, the discovery of classes of chemical compounds that can potentially be active on a biological target is basically governed by emergence. No particular explanatory frameworks are adopted to match a target with a certain compound. Only later will a phase of focused search on single targets be performed. In combinatorial chemistry, the possibility to build valid representations is too remote; therefore, the highest number of combinations is tried, and their performance are tested, with no effort spent in producing an explanation for that performance. In this sense, no representation is guiding (leading nor constraining) the search. This is a very costly strategy because with no guiding principles, all the solutions should be searched for and none can be discarded in advance. However, this strategy makes sense in chemistry and similar contexts where a closed, large set of alternatives is possible, one given by all the combinations of elements.

As a further way to generate divergent representations, the experiences of HROs indicate that to be able to imagine alternative perspectives on problems, it may be useful to picture alternative realities. HROs engage in the exercise of supposing how events would have occurred by imagining slightly different circumstances (near histories), or they use pieces of real experiences to construct a history from which a variety of unrealised but possible scenarios are generated (hypothetical histories). Although this practice is also useful for the *exploration* of solutions within known problem representations (because tiny variations help explore the different aspects of a problem), they have the potential to reveal other previously unseen dimensions of the problem.

A similar practice that stimulates imagination is adopted in creativity labs when people involve themselves in exercises where they explore creative connections between problems and solutions.[6] Outcomes might appear funny, for example, when chindogu (i.e., the Japanese art of inventing gadgets that are not useful but apparently solve an everyday problem) is practiced. Examples are the "train-nap-cap" (i.e., a hat that is fixed to the train wall behind the seat and that prevents the person's head from slumping over when one falls asleep). However, this exercise pushes one to break the inhibition towards novelty made on what is considered a normal or reasonable combination and to stretch imagination.

The second set of strategies refers to the relativity property of novelty and builds on the heterogeneous distribution of knowledge among people and communities (the "WHO") to find revolutionary novelty (the "WHAT"). The assumption is that diverse people have diverse perspectives. When among such people there is someone who sees a revolutionary novelty as something more familiar, the achievement of revolutionary novelty through his or her engagement requires the *versioning* strategy introduced in Chap. 7. To be precise, when nobody can access novelty within his or her knowledge, revolutionary novelty is achieved through the dimensioning strategy; conversely, when an actor a is aware of a solution that appears to be revolutionary novel to the other actor *b* (relative revolutionary novelty), if they acted independently for the discovery of that novelty, the actor *a* would implement a versioning strategy, while actor *b* would implement a dimensioning strategy. However, through their interaction, actor *b* would benefit from actor's *a* awareness and actor *b*'s strategy would shift from the search for

the right problem representation (dimensioning) to the search of actors who already access that problem representation and can link it to the new situation (versioning). In this case, on the one side, actor *b*'s strategy is reduced to versioning, on the other side, it is transformed into the search for the right allies who can do versioning.

The experience in the domains of both black and white novelties has shown that the practice of multiplying problem setters and solution providers can be adopted by pursuing the versioning strategy. In the case of white novelty, it has been found that crowdsourcing platforms, which are used for open innovation, allow for one to reach many potential contributors at a low cost and in a structured way. However, in a similar vein, also less-structured practices had already been observed in innovation processes where social connections allow a link of diverse knowledge perspectives, typically through a creative actor, one which embodies the bridge in the social network. Moreover, in a sociological view, the evidence of the process of translation (Callon 1986; Latour 1987) provides hints for strategies and practices to engage diverse people to contribute to the solution of a problem. In their evidence, these people are undefined, meaning that they are not related to the actor who posted the problem, nor are they a pre-selected crowd of solvers who registered on a specific platform. The same broad and undefined crowd is engaged in problem solving through town hall meetings on specific issues.

Building on the discussion in Chap. 6, in all these cases, it is crucial to clarify: (1) how questions should be formulated to avoid communicating a specific problem framing within which solutions would be searched; and (2) how to encourage potential solvers to participate. The latter has to do with motivation and incentives. To allow diverse interpretations of the problem from diverse representations and to sound interesting to diverse potential contributors, the question should be abstracted from the specific technicalities and refer only to the targeted performance (e.g., "reduce the mortality rates of women after delivery" or "invent a washing machine that does not use water"). On incentives, prizes are important, especially when problems are numerous, but motivation related to the ambition to become relevant or to increase reputation are even more important. However, both the definition of the question to ask and of the people to engage reflects an additional

decision on the role that the focal actor would tailor for himself or herself. Both the literature on social networks and the evidence on crowdsourcing indicate that the focal actor should play his or her role in very different ways when the problem is well-defined or ill-defined.

When the problem is well-defined and a perspective into the problem is clear, the focal actor is typically searching for a solution within a known problem representation. The actor knows what he or she does not know and targets it. In this case, the focal agent can play the role of the "800-pound gorilla"[7], maintaining his or her lead over the problem's definition, solution development and the selection of potential solvers who have been invited to join the project. Whether a solution is successfully developed depends largely on the 800-pound gorilla's problem framing, which is transmitted through the question he or she posed and made relevant. And this problem can only be made relevant through a good system of incentives. Novelty resulting from such processes is conservative.

By contrast, when the problem is ill-defined a perspective into the problem must still be found; therefore, it is not clear what is missing. In this case, agents are more likely to play the role of "anchor tenants", who will gather potential solvers but then let these solvers find their own way into the problem. This role refers to anchor tenants in malls, the main pull for customers to shop at that mall; because of their presence in the mall, other minor tenants join the location. Together, the tenants build the mall's attractiveness and increase profits. The anchor tenant asks smaller tenants to find their way towards generating more customer pull for the mall. Moving out of the metaphor, focal agents playing the role of anchor tenants act as general facilitators and attractors of other actors who would not normally be interested in participating in the problem otherwise, people who might pose problems in terms of posing questions that are meant to be inclusive and attractive towards diverse problem solvers. In this case, the possibility to end up with the right problem definition and solution development relies on the initiative of the involved solvers, not on the ability of the anchor tenant to frame the problem more specifically or direct the solution search in greater detail. The anchor tenant's ability is in keeping the problem formulation open to diverse interpretations and in raising

interest in the problem itself. In this way, new knowledge perspectives arise from the contributions of the involved actors. Novelty resulting in this case would typically be revolutionary.

To sum up, 800-pound gorillas are focal actors who know their unknowns, and they target them. Anchor tenants are agents who do not know their unknowns, and they cannot specify these unknowns into more precise questions. These kinds of roles and the corresponding problems (well-defined for the 800-pound gorilla or ill-defined for the anchor tenants) are typically both found in crowdsourcing platforms. However, the range of novelty they can reach is very different: they target respectively designed and emergent novelties that are typically conservative and revolutionary novelties.

Taking the case of the unknown-unknown to the extreme, a third role could be identified as the "the prince of Serendip", who is the typical actor open to seizing serendipity, intended as the novelty which is found without having been searched. The prince of Serendip is an actor who finds himself facing questions that were not asked and solutions that were not directly searched for. When serendipity occurs through occasions of interaction among agents, solutions emerge that can solve unsolved questions. The prince of Serendip is a focal agent who is open to emergent solutions and questions and is prepared to grasp them. The engagement of other people is not motivated by a search for solutions to the problems he or she has in mind, but rather, this actor looks to the emergence of problems and solutions that can be defined and solved together. The prince of Serendip controls the emergence of novelty only in the sense that he or she can build occasions for meeting actors with diverse perspectives and can try to tackle his or her cognitive and organizational blinders that would push him or her to withdraw into well-known perspectives and domains of expertise. In this extreme case, when novelty consists of the extremely unknown-unknown, something that cannot be imagined, the only way to target it is to ride the apparent paradox of designing openness.

This book offered a definition and a perspective on novelty, bringing together diverse and distant areas of research, hopefully triggering further debate and research on the origins of "the new" in organizations. This last chapter also draws some implications for organizations,

and develops a different expression of control and intention of organizations that is not directed towards designing solutions to be found, but rather towards an increased exposure to emergent novelty and to the unknown-unknowns.

Notes

1. More precisely, the network module consists of genes, transcription factors, RNAs, enzymes and metabolites.
2. Moreover, research has shown that also social networks play a role in diseases: familial, friendship and sexual networks play a role in the spread of pathogens, including when those diseases do not spread through or because of interaction. For example, consider obesity: when two persons perceived each other as friends, if one friend became obese during a given time interval, the other friend's chances of following suit increased by 171 percent.
3. *The Economist*, "The New Normal," March 26, 2016.
4. These cases were discussed in Chap. 6.
5. Note that *undetermined* or *undetermined* means not yet decided or settled or not yet established while *indeterminate* or *indeterminate* means impossible to settle or decide. In an undetermined world, outcomes are undetermined, meaning that they have not settled, but they are also indeterminate in the perspective of the solution seeker because for him, they are impossible to settle.
6. For example, in the Tina Seeling course on creativity and innovation at Stanford (TEDxStanford, published online August 1, 2012).
7. See Sect. 6.4.2 for the definition for "800-pound gorilla", "anchor tenant" and "Prince of Serendip".

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