Knowledge Management and Innovation

Smart Innovation Set

coordinated by
Dimitri Uzunidis

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Knowledge Management and Innovation

Interaction, Collaboration, Openness

Pierre Barbaroux
Amel Attour
Eric Schenk

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Contents

General Introduction

Knowledge Management at the Heart of Innovation

As the process consists of launching new products and services out into the market, innovation is one of the engines of economic growth. It is behind the rise of increasing returns to scale, of the expansion of the size of markets and of the deepening of labor division. It conditions the productivity gains locally registered at the scale of firms and industries, and globally registered at the scale of regions and countries. Finally, it constitutes a privileged strategy for economic actors in order to develop and create value, and to obtain favorable competitive positions. Even if the way of managing innovation activities differs from firm to firm, from region to region or from country to country, innovation always suggests the creative mobilization of tangible and intangible assets in view of inventing and commercializing new ideas (Box I.1). It is a question of combining human resources and financial means, production and communication technologies, regulations and norms as well as cultural and professional values, and aligning them with a political and/or strategic value-creating vision. This is true for the scale of a firm, a territory, a region or a nation.

Even if, today, the definition of innovation in terms of process elicits a broad consensus on behalf of researchers and practitioners, many questions are still open:

– How do economic actors, firms and territories organize themselves in order to innovate?

– Which capabilities do they need to mobilize in order to invent and commercialize new products, services or technologies?

– How do they acquire these capabilities?

– Which are the processes capable of nourishing the acquisition and development of an innovation capability?

In the specialized literature, innovation designates a process which implies the coordination of a set of scientific, technological, organizational, financial, political and managerial activities whose aim is to invent and then commercialize new knowledge [DOD 08]. Be it the innovation of a product, a service, a structure or a procedure, it is important that knowledge is new at least for the actor (individual, firm or public organization) who seeks to exploit it on a commercial, social or political basis. It may also appear new to its partners, customers or users, or its competitors. No matter its nature, be it technological, organizational or institutional, innovation is always introduced by its authors as a process whose aim is to renew the needs and individual or collective capabilities, the social practices or the organizational modes of transactions and production, as well as the norms, regulations and values that guide and frame these practices and these organizational modes.

Box I.1. *Definition of innovation*

In the introduction of his work *Open Innovation* published in 2003, Henry Chesbrough suggested a comparative analysis of the innovation processes used by Lucent and Cisco companies. While the first massively invested in the development of its internal research and development (R&D) capabilities, the second focused its technological expertise on identifying the most promising external sources of innovation. While the first strategy aims to develop an internal innovation capability and a knowledge capital from which to elaborate innovative technological trajectories, the second offers the firm the means of accessing dispersed knowledge and competencies that will enable it to invent and commercialize new products, services or technologies thanks to the use of a collaborative agreement and an intelligent investment policy.

From this comparison, Chesbrough shows that firms no longer manage their innovation activities by relying exclusively on their internal capabilities for R&D. Rather, they build on the combination of internal and external sources of knowledge, leaving a large space for interaction and collaboration between partners, customers, suppliers, research laboratories, universities, financial institutions and governmental agencies [VON 02, FIL 09].

The decompartmentalization of firms' innovation capabilities is a feature of what Miller and Morris [MIL 99] named the fourth generation of R&D. According to this approach, innovation depends on the capability of firms to combine diverse internal and external sources of knowledge, tacit and explicit, with business processes that depend on equilibrium between market forces and technological dynamics. This transformation of innovation management models is accompanied by the emergence of new forms innovation process organization that depend on the collaboration and sharing of knowledge between the participating actors in the innovation process [BAR 14a].

In this context, researchers have studied the characteristics of these novel approaches to innovation, exploring the modalities of innovation management in knowledge-intensive industries, but also in more traditional industries. The resulting models include the paradigm of *open innovation* made popular by Henry Chesbrough, the theory of *innovation through users* introduced by Eric von Hippel, the multiple perspectives on innovation communities defended particularly by Patrick Cohendet or the theory of business ecosystems and business models developed by James Moore. All of these approaches consider innovation to be the result of interaction, collaboration and opening of firms' R&D departments, implying the combination of tangible and intangible resources incorporated in a variety of distributed organizational and technological contexts. The case of Airbus BizLab is illustrative in this respect (see Box I.2).

Enterprises like Xerox, IBM, Procter & Gamble or Phillips [CHE 03, DOD 08] have chosen to put into practice an open business model based on the principles of interaction and collaboration. These initiatives demonstrate the extent to which innovation management practices are witnessing a radical change. These examples equally reveal that the adoption of an open business model entails an upheaval in the enterprise's activities which are not directly tied to R&D, particularly marketing, distribution, appropriation of return or the management of information. In the words of Chesbrough [CHE 03, pp. 51–52]:

> "*The new logic turns the old assumptions on their head. Instead of making money by hoarding technology for your own use, you make money by leveraging multiple paths to market for your technology. Instead of restricting the research function exclusively to inventing new knowledge, good research practice also includes accessing and integrating external knowledge. Instead of managing intellectual property (IP) as a way to exclude anyone else from using your technology, you manage IP to advance your own business model and to profit from rivals' use*".

Airbus Group created BizLab, an open and collaborative network organizational structure, whose mission is to facilitate innovation through a support program for projects with a strong innovative potential. BizLab provides the project supporters with a variety of resources (i.e. working spaces, communication and collaboration tools, coaching, expertise, partner network, financing, marketing, legal advisors, etc.), allowing them to accelerate the invention process and the marketing of new ideas in the form of innovative products and services. The BizLab is open not only to the intrapreneurs of Airbus group but also for the most part to entrepreneurs whose projects emerged outside the frontiers of the group. The first site of BizLab was inaugurated in Toulouse in March 2015, and two other sites (Hamburg and Bangalore) are going to extend the geographic imprint of what constitutes the first open innovative network of Airbus group. The selected projects benefit equally from available resources in the extended ecosystem of Airbus group, particularly thanks to partnerships that the group has developed with equivalent structures developed in other sectors by enterprises like Microsoft (Microsoft Ventures), Orange (Orange Lab), Coca Cola (The Bridge), Google, Apple or even the start-up accelerator Techstars Boston.

Box I.2. *Airbus BizLab: the innovation accelerator at Airbus Group*

In the face of such changes, the solution of vertically integrating the "sources of innovation" (to paraphrase the title of the publication by Eric Von Hippel) in view of controlling them appears expensive, even dangerous. On the contrary, the idea of combining internal and external resources in order to develop and market new goods and services appears pertinent and rational. Chesbrough [CHE 03, pp. 53–54] uses the example of the pharmaceutical firm Merck which, in the nineties, chose to redefine the perimeter of laboratory competencies of R&D in order to integrate knowledge developed outside of its boundaries. Capitalizing on a corporate culture that privileges scientific excellence, the laboratory heads were provided with a route map that not only calls for internal research activities in the preferred knowledge domains of the firm (i.e. biotechnology, genetic research) but also equally encourages the contact of Merck laboratories with all external resources considered useful and pertinent for the development of its commercial offer (i.e. university or private laboratories, users communities, rival enterprises). For this, the firm must count on internal capabilities, allowing it to identify and connect, to absorb and to combine [COH 90] this diversity of resources.

As it changes the way in which firms manage the phases of invention and commercialization of new products and services, this transformation of innovation models is accompanied equally by a modification in the knowledge management processes which are mobilized to innovate. To trust a third party (i.e. research laboratories) with a part or the whole of the work load consisting of developing new knowledge or new concepts during the ideation phase (invention phase; Arthur [ART 07]), new challenges arise for the innovating firm. In particular, this requires the development of new capabilities in the matters of creation, codification, integration, sharing, transfer, protection and valorization of knowledge. Besides, the available knowledge outside the firm's boundaries must be able to be used in complement with the internal knowledge of the firm, requiring integration mechanisms that involve specific *capabilities*, particularly the capability to absorb knowledge [COH 90]. It also requires deploying methods of interaction management between the partners that differ from traditional management modes. The structures of governance, leadership forms, sharing mechanisms and knowledge control involve particular organizational capacities [AMI 04]. Consequences of the transformation of innovation models also concern the phase of commercialization. This calls for appropriation regimes adapted to the stakes of interaction, collaboration and opening. The innovative firm must be capable of displaying the modalities of protection and sharing of knowledge, adapting these to the features of new business models [TEE 10].

Aims of the publication

If we suppose that knowledge and innovation are two faces of the same coin, then it is pertinent to consider that knowledge management is inseparable from the way in which firms organize themselves in order to innovate. However, in spite of significant advances in research, we have no more than a fragmentary knowledge of the specificity of processes and practices of knowledge management that underlie innovation, particularly when it depends on open organizational forms and interactive, collaborative, community-based or participative business models.

The relationship that exists between these new innovation management models with the processes and practices of management knowledge deserves to be studied in a systematic manner. There are two reasons for this: on the one hand, research papers on management knowledge and the innovation capabilities of the firms are not sufficiently articulated (i.e. open, collaborative, communitarian, participatory innovation ways); on the other hand, the processes of knowledge management on which these depend have not been the object of systematic analysis.

Thus, the aim of this book is to offer students, researchers and managers the keys to understanding, assisted by concrete illustrations, that will enable them to articulate the processes and practices of knowledge management put into practice by firms in order to innovate in an interactive way.

Outline of the plan

This book is structured in three chapters. The first chapter addresses the following question: what connections can we establish between the processes of knowledge management, the development of firms' innovation capabilities, and their performance? To answer this question, we proceed in two steps. We start by investigating what researchers say about the relationship between knowledge management and firms performance. One of the essential lessons to be learned from research is that the performance of teams, firms and networks of firms in the matter of innovation depends on the quality of their knowledge processes on the one hand, and on their knowledge management practices on the other hand. In the second instance, we explore the concept of innovation capability by asking about the way in which knowledge management processes nurture the firm's innovation capabilities. This exploration leads us to define innovation capability as a dynamic capability, which can be divided into knowledge management processes and organizational competencies mobilized during the different phases of the innovation process. Economists have long suggested that to invent new products (goods or services, technologies, procedures or organizations) and to commercialize them does not require the same organizational capacities or the same learning processes [SCH 34, PEN 59, NEL 82]. This result, regularly confirmed by research, is important since it presents innovation as a process anchored in the management of knowledge and one that links together the phases of invention and commercialization in a particular context. In this framework, certain knowledge processes are associated with the accomplishment of certain tasks specifically attached to one of the phases, and others are mobilized to accomplish tasks whose performance engages different phases in the innovation process.

The second chapter of the book deals with the variety of processes and knowledge management practices mobilized in order to innovate. Which processes are associated with the different phases of the innovation process? What are the features of knowledge management practices used by firms during these different phases? In this chapter, we invite the reader to consider innovation as the result of three fundamental knowledge management processes: the generation of knowledge (by absorption, rearrangement and integration of knowledge), the application of this knowledge (according to the mechanisms of conception, sharing, transfer and coordination of knowledge) and the valorization of knowledge (protection of knowledge and appropriation of returns from innovation). These processes constitute the core activities of knowledge management of innovating firms. Together, they define the components of their innovation capability considered as a dynamic knowledge capability (see Chapter 1).

Finally, the interactive approaches to innovation are presented in the third chapter of the book. After introducing the federating process of open innovation, we distinguish three more specific approaches: the user-centric innovation, the community-based innovation and *crowdsourcing*. All of these share the consideration that knowledge mobilized by actors in order to innovate is distributed inside and outside the organization's boundaries.

In this context, the innovative firm must be capable of identifying, combining and coordinating a variety of innovation sources suggested by very different individuals and organizations (i.e. suppliers, clients, R&D enterprises, consultants, users' communities, etc.). How does the innovative enterprise proceed? Which are the knowledge processes sustaining these interactive approaches of innovation? The third chapter provides answers to these questions.

1

Innovation Processes, Innovation Capabilities and Knowledge Management

Knowledge management can be defined as a set of processes, principles and techniques leading to the creation, organization, distribution, use and exploitation of the enterprise's knowledge [LOP 11, PAL 09]. The knowledge management processes frequently discussed in the specialized literature are the generation, the transfer and the use of knowledge. Coombs and Hull [COO 98] suggest adding the processes of identification, capture, modification, validation, contextualization and knowledge closure, in order to enrich the traditional vision of knowledge management, deeply rooted in the practices of information management. In a broader sense, knowledge management depends on organizational practices that consist of articulating knowledge processes with knowledge domains, performance fields, and formalized and operational action models [COO 98]. The aim is to offer the firm the means for efficiently exploiting its intangible assets, but equally to access information and knowledge useful for its development.

Despite significant theoretical advances, the influence of knowledge management on the innovation capability of the firm is still unevenly understood by managers. The latter are relatively ignorant of practices and operational techniques that enable the exploitation of tangible and, mostly, intangible resources in view of developing the firm's potential for innovation. The effects of knowledge management on the capability for innovation and the performance of firms have not been studied in a systematic way by researchers. What does the literature teach us about the relation between knowledge management, innovation and the performance of firms? The following section addresses the theoretical and empirical pertinence of this relationship.

Knowledge Management and Innovation: *Interaction, Collaboration, Openness*,
First Edition. Pierre Barbaroux, Amel Attour and Eric Schenk.

1.1. Does knowledge management improve the performance of innovating enterprises?

More and more analysts, managers and researchers are envisioning that the performance of firms depends on their ability to efficiently manage their intellectual resources, and informational and knowledge assets [RAN 06]. Noruzy *et al.* [NOR 13], for example, show how knowledge management positively influences organizational innovation and, consequently, the performance of firms. In their study, the authors suggest that the capability of leaders to transform the systems of norms, rules, values and shared beliefs of a firm has a positive impact on organizational innovation through the moderating role played by organizational learning and knowledge management.

More generally, authors who deal with the question of performance defend the hypothesis that knowledge management has a direct positive impact on the innovation capability, and, indirectly, on the performance of firms. In their research papers, innovation is either considered as a moderating variable between knowledge management and performance, or as the main variable. The questions they deal with are as follows: How can knowledge management favor organizational performance? Does it have a direct impact on performance, or an indirect impact thanks to the improvement of the innovative potential of firms? Answering these questions supposes understanding how the activities of firms as a matter of knowledge management influence their capability for innovation.

1.1.1. *Does empirical research confirm the existence of a connection between knowledge management and the performance of innovative enterprises?*

For about the last 10 years, numerous scientific studies have proposed "testing" the empirical validity of the hypothesis of a direct or indirect relation between knowledge management strategies, innovation and the performance of firms [YAN 10, LAI 14, CAN 11].

Lopez-Nicolas *et al.* [LOP 11], for example, develop an econometric study dealing with a panel of 310 Spanish enterprises. Considering that the direct impact of knowledge management on performance depends on the type of strategy implemented by the firm, the authors divide the concept of performance into three dimensions: financial, processes and internal. In this context, the authors propose examining the existence of a direct relation between the personalization and codification strategies, on the one hand, and the performance dimensions, on the other hand [LOP 11]. They then study the indirect effects of each strategy on the performance of firms, by exploring their impact on their innovation capabilities. The results of their econometric study confirm the existence of a positive direct relationship between the implementation of a knowledge management strategy, the increase in the innovation capability and the performance of enterprises. More precisely, the results suggest that the personalization and codification strategies have an equivalent positive impact on innovation: there are no differences in nature or type regarding the impact of the knowledge management strategy deployed by the firm on innovation [LOP 11]. Nevertheless, a detailed analysis of results shows that knowledge management strategies have a relatively higher impact on financial performance than on process and internal performance dimensions. Finally, the indirect effect of knowledge management strategies on the performance of firms via an increase in their innovation capability is empirically validated.

This result is confirmed by Yang [YAN 10]. This author also studies the variables susceptible of moderating the relation between knowledge management strategies and the strategic performance of firms. The author particularly explores the mediating role of the following variables: 1) the incentive and reward system (H1a), 2) process innovation (H1b), as well as the firm's competencies in matter of 3) the integration of previous knowledge cumulated on preceding projects (H2a), 4) the market intelligence (H2b) and 5) the sharing of knowledge between organizations (H2c) [YAN 10, p. 218]. From a panel of 500 high-technology Chinese firms, the author tests the empirical validity of the aforementioned hypotheses. The results obtained confirm the existence of a positive relation between the variables and the performance of firms [YAN 10, p. 220].

Exploring the role of collaboration in matter of knowledge management, Cantner *et al.* [CAN 11] also study the influence of knowledge management processes on innovation and the performance of firms. The authors pay attention to the knowledge processes guided by demand, whose aim is to favor the sharing and the creation of knowledge. In this framework, the authors consider that the management of knowledge has a different impact on the performance of firms depending on the type of innovation that they develop. Three types are thus distinguished: incremental innovation, radical innovation and process innovation. The hypothesis formulated by the authors then concerns the existence of a positive relation between the display of a collaborative knowledge management strategy and the three types of innovation mentioned earlier (hypothesis named H1, H2 and H3). Building on an econometric study dealing with a panel of 1335 German enterprises, Cantner *et al.* [CAN 11] reveal, on the one hand, that the management of knowledge improves the success of firms in terms of product innovation and, on the other hand, that its influence differs according to the type of innovation (incremental or radical). Finally, the collaborative management of knowledge rests without effect on process innovation.

These papers clearly show that a positive relationship exists between knowledge management, innovation and the performance of firms. If we want to improve our understanding of how knowledge management technique practices and processes improve the performance of innovative firms, it is necessary to go beyond econometrics. What about the impact of knowledge management on the innovation projects carried by the firms? What is the real influence of the "contextual" variable on knowledge management and innovation?

1.1.2. *Beyond the enterprise: knowledge management, innovative territories and innovation projects*

In the academic literature, the firm is not always the unit of analysis of the relation between knowledge management and innovation. Researchers have studied the role of knowledge management in relation to project management, or to the innovation dynamics of a territory. In this way, considering an industrial cluster in Taiwan, Lai *et al.* [LAI 14] study the moderating role of knowledge management in performance, not of individual firms but of an industrial cluster. In this study, the authors underline the positive role of clusters in terms of information circulation and knowledge sharing among a great diversity of public and private stakeholders [LAI 14]. The sharing and knowledge exchange processes are here essential to innovation within clusters. In practice, the operational performance of the firm in terms of knowledge management and, by extension, of innovation is positively influenced by the collective dynamics boosted by the industrial cluster. It is the institutional and industrial localized context (the cluster) that favors the creation and sharing of knowledge, the two central processes in terms of knowledge management at the service of innovation. This result is confirmed by Silvestre *et al.* [SIL 14] in the case of industrial clusters localized in developing countries. The authors point out that the innovation capabilities of firms belonging to the mineral cluster (Granite) of the region of Padua (Brazil) are strongly constrained by the clusters' properties in terms of knowledge management. Indeed, the cluster is characterized by a weak entrepreneurial culture associated with the absence of expertise and training connected to the firm's activities, a high level of informality in the relationships between individuals, and the relative weakness of communication and knowledge sharing within the cluster and beyond, toward other industries [SIL 14]. Enlarging the perspective, the papers dealing with the localized systems of production [ASH 05, ASH 07] have shown how the properties of the institutional, industrial, technological and regulatory context, in which the interactions between actors operate, play a moderating role in the relation between the management of knowledge and the performance of innovative firms. The works of Moore [MOO 93, MOO 96, MOO 06] about business ecosystems have also highlighted the importance of knowledge processes in the development of innovative business ecosystems [ATT 16].

The theoretical framework of knowledge management has been equally mobilized by researchers specialized in the study of innovative project management [TOD 15]. Indeed, project management is therein perceived as a collaborative activity involving the combination of different processes, sources and types of knowledge enabling the organization to create value. The management of an interorganizational innovation project then requires the mobilization of knowledge processes such as combination, coordination or socialization, in complement with the generation and integration of knowledge. In this context, the knowledge management practices implemented by the actors engaged in a project have a direct influence on the performance of the project itself [REI 14]. Each step of the development of a project is marked by one or many knowledge processes. The authors refer, for example, to the process of knowledge creation to characterize the cognitive activities performed during the conceptualization phase of the project. This uncertain and dynamic – even ambiguous – phase features activities of the so-called knowledge generation performed ahead of the project [AKB 14]. In the same vein, other authors have highlighted the role of knowledge integration processes during the upstream phases of the project [YAN 05]. If the generation of knowledge is important, it is also essential to integrate knowledge because of its dispersed character, on the one hand, and the radical uncertainty that characterizes innovative projects, on the other hand [AHE 14a, AHE 14b]. It appears that the generation and integration of knowledge procedures are jointly mobilized during the same phase of the innovation process; thus, the alignment of knowledge processes mobilized during their different phases becomes essential to the performance of the project [REI 14].

From this perspective, the absorptive capability[1] [COH 90] of the firm has a direct impact on its aptitude to efficiently manage innovative projects [ESC 09]. Here, the integration of the flux of external knowledge and the cumulative development of internal knowledge [ALE 11] require the mastery of specific competencies on behalf of the firm. Gallego *et al.* [GAL 13] thus suggest that the firm's absorptive capability depends on the intensity of its R&D activities, the latter conditioning its aptitude to cooperate. However, firms cannot depend only on their internal resources to develop cooperative relationships, at the risk of reducing their innovative potential [GAL 13]. The will to open themselves and to interact with external agents, particularly those belonging to the scientific community, thus plays a crucial role in the performance of firms in terms of innovation (see Box 1.1).

Siemens, a German multinational firm specialized in electrical, electronic, automatic and digital technologies, has developed an environment that favors the establishment of innovative partnerships according to a model inspired by the Open Innovation paradigm. The department of R&D of the group (called *Corporate Technology*) develops collaborative relations with a variety of research actors (university and research labs) and firms (*start-ups*) with the aim of inventing and commercializing new goods, services and technologies susceptible of generating value. The support infrastructure for innovative firms (start-up) relies on three entities. The *Technology-to-Business* (TTB) centers of Berkeley, Munich and Shanghai offer to the young external innovative firms outside the Siemens group a whole of resources and expertise in view of sustaining, from the initial phases of their projects, the invention of rupture technologies with strong commercial potential. The purpose for Siemens is to access promising technologies externally developed in view of preparing their internal exploitation. In parallel, the TTB accompanies the creation of internal *start-ups* within the Siemens group with the aim of testing the commercial potential of innovative technologies that do not necessarily belong to its inherent savoir-faire. The *Siemens Novel Businesses* (SNB) constitute the second pillar. Their role consists of favoring the articulation of the

1 See Chapter 2 for the definition.

invention phase with the commercialization phase. The SNB finance the testing and experimentation phases of new business models encouraged by innovative technologies, before their progressive integration in the form of *Business Units* of the group. The *Siemens Technology Accelerator*, the third pillar of the innovation strategy of the group, has the mission of commercializing the technologies developed and/or supported by Siemens whose business models feature the activity domains in which the enterprise is little active. The cooperation with universities and the research community completes the preceding methods by inscribing the innovation strategy of the group in the long run. The *Centers of Knowledge Exchange* (CKE) have thus been placed in Berkeley, Georgia Tech, *Technical University* (TU) of Berlin, DTU Copenhagen, TU de Munich, FAU Erlangen-Nuremberg and Tsinhua (Chinese University). Each CKE benefits from the financial support of the firm which in return takes part in the piloting of research activities, recruiting of researchers and the distribution and exchange of knowledge.

Box 1.1. *The strategy of open innovation at Siemens*

1.2. Innovation capability and knowledge management

Innovation requires the mastery of a capability to conceive new ideas, to organize their integration into new products or services, to coordinate the actors and the resources taking part in the development of innovative products or services and to commercialize them, extract revenues from them and generate value for the innovation stakeholders [BAR 14b]. This innovation capability is a dynamic capability [TEE 07] as its aim is to transform the resources available and accessible to the organization, as well as to renovate and enlarge their potential for creating value. The dynamic capacities of the firm are then essential to innovation: they guide the renewal of resources by combining different learning modes (i.e. exploration, exploitation, interaction, experimentation) and transform knowledge into firms' competencies, therefore providing them with a competitive advantage. In addition, dynamic capacities are divided into aptitudes, abilities and elementary competencies related to the accomplishment of knowledge-intensive tasks and activities (i.e. generation, integration, absorption, codification, diffusion, sharing and application of knowledge). Finally, the development of dynamic capacities is influenced by the firm's knowledge management practices and, at the same time, the implementation of knowledge management practices is, by itself, a dynamic capability. In other words, the innovation capability of the firm is a dynamic capability.

1.2.1. *The decomposition of innovation: invention and commercialization*

"To innovate, is easy. The difficulty is to transform an innovation into real business". This quotation from Michael Dell (founder of the eponymous enterprise Dell Inc.), in January 2005 before an assembly composed of French CEOs, suggests that it is not enough to invent something new in order to innovate. Still, it is important to be capable of valuing it. Innovation can thus be divided into distinct phases, articulated in time (see Figure 1.1). Economists distinguish two phases: invention and commercialization of the innovation. Together, these two phases define innovation as a process.

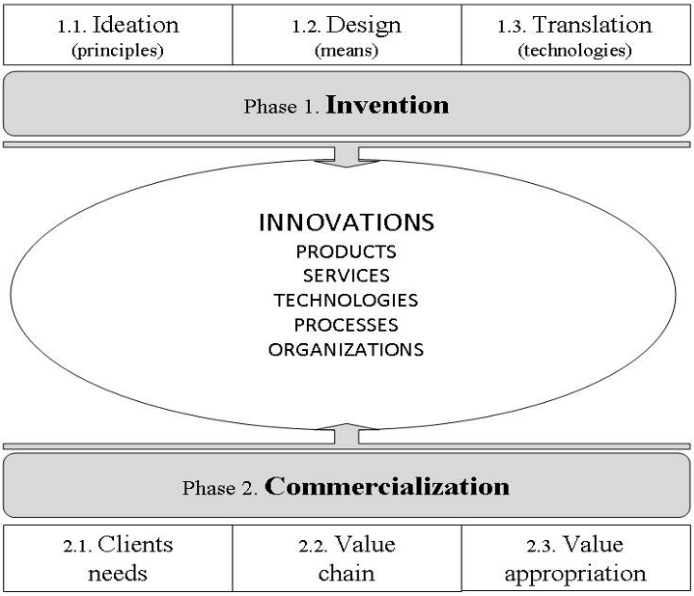

Figure 1.1. *Innovation typology and partitioning of the innovation process*

According to Arthur [ART 05], the invention phase can itself be divided into three stages:

1) Ideation of a basic principle;

2) Conception of the means to satisfy a need;

3) Translation of the basic principle into operational technology.

The departure point of the invention phase is the identification of an economic opportunity generated by the application of one (or various) basic principle(s) in connection with a real or potential need [ART 07]. The economic opportunity can equally result from a scientific and technical discovery [BAR 14a] related to industrial and commercial real, latent or potential applications. This recognition phase and/or construction of a business opportunity is later accompanied by the search for the means to satisfy the constraints that weigh over its performance and to solve the problems that this elicits. Arthur indicates that it is a question of conceiving a way ("a route"; Arthur [ART 07, p. 279]) to connect the solutions and the constraints with the basic principle(s). Then comes what the author calls a "*moment of connection*, *because it connects a problem with a principle – an effect in use – that can handle it"* [ART 07, p. 280]. For the principle thus conceived to become an invention, it must be translated into a functional technology. This last step of the invention phase consists of taking a "*mental concept to physical embodiment* (…) *Solutions that were conceptual must be produced in physical form, and sub-problems that were partially bypassed must be dealt with directly*" [ART 07, p. 281]. This translation engages a basic principle development period during which knowledge is cumulated and technological challenges are progressively handled until a functional technology is produced (Box 1.2).

With the intensification of the Cold War during the fifties, the financing of the research activities in the domain of information and communication technologies (i.e. computers, networks, and satellites) became a priority of the American government. The *U.S. Advanced Research Project Agency* (ARPA) was thus created in 1958 by the American Defense Department in order to pilot the projects it financed and to maintain the technological superiority of the U.S. Armed Forces in terms of communication, command and control. One of the most accomplished achievements of the ARPA agency concerns the development of the first distributed communication network: ARPANET. In the mid-sixties, computer science was not yet a mature academic discipline, the number of computers was very limited and the research community was still embryonic. At the end of 1966, Lawrence Roberts (former researcher at MIT) rejoined the ARPA to develop the communication network project of the agency. He published his "plan" for the ARPANET on a memorandum with the title "Multiple Computer Networks and Intercomputer Communication" which he introduced at the ACM (*Association for Computing Machinery*) conference of Gatlinburg in October 1967. In the same year, a research group was reunited by Lawrence Roberts to discuss the specifications of the future network. This group called itself the *Network Working Group* (NWG). The initial aim of the NWG was to promote informal discussions between researchers, with the aim of exploring intuitions, suggestions or critics susceptible of facilitating the development and exploitation of the network. Based on the values of openness and critical thinking, the group encouraged the participation of users and developers in the tasks of formulation and resolution of problems, and the sharing of good practices. The working notes of NWG started to circulate to the participants from April 1969 onwards. Their edition gave birth to the principal reference in terms of ARPANET documentation called the "*Request for Comments*" (RFC). ARPANET was above all a research project with a purpose to prove experimentally the pertinence of communication and resource sharing theories between geographically dispersed computers. In this context of experimentation and validation of concepts, the task division and the attribution of responsibilities between the diverse participants of the project depended on their respective competencies in their expertise domains. The hierarchy of problems determined, in fact, the nature of the relations between the actors. By chance, the scientific and technical expertise indispensable to the deployment of the experimental network was known by the ARPA agency since the majority of the researchers composing the NWG had previously worked for the U.S. government. However, it was a R&D enterprise, Bolt Beranek and Newmann (BBN), which was chosen for developing the interfaces. The interfaces were critical components of the network because they allowed distinct host sites to communicate via a simple telephone line. In August 1969, seven months after having won the bidding competition, BBN achieved the development of IMP (*Interface Message Processor*) interfaces. In September 1969, a first communication protocol "host-interface" (Host-IMP) was jointly defined by the researchers of the university of California (UCLA) and BBN. UCLA then received the first IMP interface and became the first node of what would constitute the "ARPANET" network. A month later, the university of Stanford (*Stanford Research Institute*, SRI) was selected to become the second node of the network in charge of collecting and putting online the data relative to its functioning. These data came directly from interfaces IMP and from the *Network Measurement Center* (NMC) situated in UCLA. Two supplementary sites were later chosen to complete the architecture of the experimental network: the University of Santa Barbara (UCSB) and the University of Utah (UCU). In the first years of the ARPANET project, the knowledge required in order to access and use the network was disseminated and shared informally between the users. With the increasing number of computers communicating via the network, the problems associated with protocols became more complex and required a standardizing effort and a codification of knowledge. It was more and more indispensable to define generic standards in order to reduce the access costs to the network to a minimum. The *Network Working Group* (NWG) was precisely in charge of specifying the protocol techniques and of codifying *host-to-host* communication standards in view of facilitating the diffusion and the adoption of the network. The generation and codification of knowledge had a major impact on the evolution of the project. In June and July 1984, John Reynolds and Jon Postel cosigned the RFC 901 and 902 notes which established the protocols and conventions facilitating the transition of the ARPANET to the INTERNET. The drafting of the RFC notes was pursued for a long time after the *Network Control Protocol* (NCP) standards became *Transmission Control Protocol/Internet Protocol* (TCP/IP) standards throughout the eighties. The RFC documentation is still used within the computer science community.

Box 1.2. *The invention of the Internet: a collaborative research project supported by an open community of knowledge management [BAR 14a]*

The second phase of the innovation process merely concerns the definition of a value appropriation regime. The purpose of this phase consists of selecting and then combining the distribution channels of innovation, including the customers' needs, the value chain of innovation, the partner network implied in the exploitation of innovation, and choosing a juridical regime for the protection of the intellectual property and the allocation of appropriation rights issued from the commercialization of innovation [TEE 86]. This decomposition of the innovation process calls for a reflection on the nature of the tasks and activities that the organizations perform in order to innovate. The invention and commercialization phases indeed mobilize different knowledge types and processes and require specific aptitudes, competencies and capabilities.

1.2.2. *Innovation activities and aptitudes*

According to Romijn *et al.* [ROM 02], the innovation capability of the firm results from a set of organizational aptitudes enabling them to create new technologies by absorption and recombination of existing and available resources. Wang and Ahmed [WAN 07], on their behalf, distinguish three components of the firm's innovation capability. The first component concerns the identification and the capitalization of market opportunities (adaptation component). The second component involves the recognition of the value creation potential of external resources, the assimilation of these resources and their application to commercial ends (absorption component). The third component specifically concerns the development of products or new markets (innovation component). Burgelman *et al.* [BUR 04] particularly suggest that the innovation capability can be divided into design competence (i.e. anticipation, planning and allocation) and realization competence (i.e. organization and commercialization). Innovation then requires the ability to conceive a new product or a new technology responding to a need or a new demand (conception capability; Ulrich [ULR 95]), but equally to know how to deploy the most efficient organizational form in view of developing and commercially exploiting the invention [SAN 96]. Here, the increasing complexity of technological innovations supposes mobilizing and integrating a variety of internal and external knowledge [COH 90], the latter being possessed by a large number of participants in the innovative process [BAL 11]. Moreover, the innovative enterprise must at each stage of the process obtain the financing adapted to the maturity level of the new technology, product or service that it is developing before its exploitation [GOM 01]. Finally, the firms must find ways of making profit from the innovative investment by choosing the most efficient appropriation regime in view of commercially exploiting the innovation [TEE 07].

Each of these design activities (of product and of organization), financing, collaboration between the parties, knowledge integration or profit appropriation resulting from the innovation depend on distinct organizational aptitudes (see Table 1.1). These can be implemented by an individual entrepreneur, a firm or a set of organizations that collaborate to innovate [BAR 14b]. In this view, the innovation process necessarily appears to be organized, piloted and coordinated by a firm (or a group of firms), or an individual behaving as an entrepreneur and an innovator. For Hatchuel *et al.* [HAT 09, p. 161], "*every innovation demands a collective action and an organized environment that at least provides the competences, the social artifacts and the necessary resources*". As a consequence, these organizational capacities evolve jointly with the economic, technological and social mutations which affect the internal and external environment of firms. The competencies, artifacts and resources that enable innovation today are not the same as those which were available for the large commercial firms of the beginning of the 20th Century. Chandler [CHA 62] has shown how the exploitation of diversification strategies by the great industrial enterprises at that time (i.e. DuPont, Ford, General Motors) had led them to develop a multi-divisional organizational model in which the R&D activities were routinized and the innovation strategies were based on two pillars: the optimization of their internal innovation capability and the adoption of a closed regime of value appropriation [BAR 14b]. This organizational and innovation model has long corresponded to the challenges posed by the standardized mass production of goods and services. However, for about the last 20 years, this model has been less and less efficient, especially because of the changes that have taken place in the internal and external environment of the firms. The opening of national markets to competition, the multiplication of knowledge sources, especially external, the diversification of financing sources for innovation and the rising mobility of the qualified work force [CHE 03] have modified the practices and the strategies developed by the firms to manage their knowledge, to nurture their learning processes and (consequently) to innovate.

Organizational aptitudes	Definition	References
Product design	To design an architecture product/system responding to a new need	Ulrich [ULR 95]
Organization design	To deploy an organizational and industrial form adapted to the architecture of a new product, service or technology	Sanchez and Mahoney [SAN 96]
Integration, absorption and combination of knowledge	To absorb and integrate, by combination, the diverse know-how relative to the invention and commercialization of a new product, technology or service	Cohen and Levinthal [COH 90]
Collaboration	To mobilize and coordinate the variety of organizations taking part in the process of innovation. This corresponds to the capability of firms to develop innovation in a collaborative environment, sometimes open and reticular	Baldwin and von Hippel [BAL 11]
Financing	To mobilize the resources (i.e. private investors, banks, public financing) necessary to the financing of the different phases of development and innovation	Gompers and Lerner [GOM 01]
Appropriation	To choose/define a juridical framework favorable to the protection of innovation and the appropriation of profits issued from its commercial exploitation	Teece [TEE 07]

Table 1.1. *Examples of organizational aptitudes associated with the innovation capability [BAR 14b]*

In an open and knowledge-intensive global environment, the innovation capability of a firm depends on a combination of organizational aptitudes whose acquisition, maintenance and development depend both on internal and external factors. Internally, the quality of its human resources and the learning and experimentation processes it mobilizes for its R&D activities, but equally for its production activities, are determining factors. Externally, the innovation capability depends more and more on the quality of interactions that the firm entertains with its partners, including customers, suppliers, public agencies and universities. These interactions allow it to access a variety of external resources complementary to its internal resources (i.e. information, knowledge about technology and marketing, and human resources) and which appear essential to innovation. The firms thus implement open and collaborative innovation management strategies, requiring new capabilities for detecting and integrating external and internal knowledge, and creating value from them (Box 1.3).

The project *One Semi-Automated Forces (OneSAF) Objective Systems* (OOS) was launched in 1996 by the US Army. It is an innovation project in the field of simulation and modeling techniques used for education and training. The aim of the OOS project is threefold. The idea is to (1) improve acquisition cycles for simulation and modeling software, (2) to touch an enlarged community of users and (3) to obtain greater flexibility in terms of combination and integration of software applications and scenarios. The project manager designated by the *Deputy Commanding General* (DCG) is the *Army Program Executive Office for Simulation, Training, and Instrumentation* (PEO STI). The aim of the project manager (PEO STI) is to use the internally and externally available resources by linking military users of the OOS system to the extended community of developers and users of simulation and modeling software. Before that the US Army entrusted the contract to a supplier, a group comprising government representatives was constituted in view of formalizing the technical needs of the final users. An integrated team (*The Architecture-Integrated Product team*, A-IPT) was then engaged. This team, comprising the project manager (Army), a small group of civil and military *lead users,* a governmental *Think tank* (MITRE) and a research and technology enterprise (R&T, Alion), bound themselves straightaway to codify the concepts and the initial architecture of the project. Four key concepts were thus formalized. The first concerns the necessary opening of the usage domains, in connection with the diversification of the profiles of users of the OOS. The second involve the flexibility of the architecture of the OOS product. The third concerns the diversification of integrated technical systems. The last is related to the management of access rights and the modification of the source code between the civil and military stakeholders. The management of these four concepts of the OOS project needed the deployment of four categories of competence, each being associated with some essential dimensions of the project: technical competences, governance capabilities, and values and regulations individually and collectively aligned. Together, these competences formed the building blocks of the innovation capability mobilized by the members of the OOS integrated project team.

Box 1.3. *The OOS project of the US Army [BAR 09]*

1.2.3. *Dynamic capability and knowledge processes*

The capability of firms to integrate and combine internal and external resources was defined by Teece *et al.* [TEE 97] as a dynamic capability. The dynamic capability thus indicates a transformation process of firms' assets and competencies into products, services or technologies, generating value for the users or consumers [WAN 07].

The concept of dynamic capability depends more specifically on the distinction between the operational competences of the firm, considered as first-order competencies, and the capacity to transform its operational competencies, considered as a second-order competence [ELL 09]. Danneels [DAN 08] equally regards that the difference between operational competencies and dynamic capabilities depends on the distinction between operational and transformational routines. According to Wang and Ahmed [WAN 07, p. 39], the transformational competence depends on four knowledge processes. These processes aim at the integration, reconfiguration, renovation and recreation of tangible and intangible resources and of first-order competencies, particularly in the technological (i.e. production technology, information and communication technology) and commercial (i.e. understanding and anticipation of preferences and needs of users or consumers) domains. In the same vein, Verona and Ravasi [VER 03] recognize that the dynamic capabilities of the firm are fundamentally anchored in its processes of knowledge creation, absorption, integration and reconfiguration.

The dynamic capability of the firm thus enables it to develop new aptitudes to perform certain tasks and to satisfy new markets. In this sense, it is similar to a process of organizational learning, which aims at building new operational routines and competencies. From this perspective, Zollo and

Winter [ZOL 02] consider that the dynamic capabilities as well as the operational routines of firms are the result of different learning processes. The dynamic capabilities result from deliberately reflective learning processes, involving the verbalization and the codification of collective (largely tacit) knowledge. The operational routines are the fruit of a learning process resulting from the accumulation of experience under situations of repeated tasks. The authors then propose to represent the development of dynamic capabilities throughout a knowledge evolution cycle consisting of four phases:

1) The generation of new knowledge, essentially tacit, by combination of internal as well as external knowledge and information, and by reformulation of existing problems.

2) The selection of the generated knowledge through the evaluation of their potential to transform existing tangible and intangible assets, as well as their degree of legitimacy with regard to the existing norms, values, rules and routines.

3) The diffusion of knowledge by replication to all the units that constitute the firm. The diffusion is equivalent to a test period susceptible of producing useful information in view of evaluating the performance of new knowledge in different contexts from those that prevailed during the variation-selection phases.

4) The retention (i.e. the capitalization) of knowledge indicates the phase of transformation of new knowledge into operational routines corresponding to structures of stable behaviors that enable the firm to respond to a variety of internal and external stimuli [ZOL 02, pp. 343–344].

We understand along with Zollo and Winter [ZOL 02] that knowledge management processes and the dynamic capabilities are "*intimately connected*" ("*closely intertwined*"; [CEP 07, p. 427]) since the development of dynamic capabilities demands, in fact, the accumulation, the codification and the sharing of knowledge.

Building on the works of Jensen *et al.* [JEN 07], Herstad *et al.* [HER 15] arrive at a similar conclusion, demonstrating that the development of firms' dynamic capabilities depends on two types of learning processes. The first type is based on the codification of knowledge relative to the resolution of local problems according to a scientific and experimental method. This learning process is associated with a specific mode of innovation called "*science–technology–innovation*" (STI) by Jensen *et al.* [JEN 07, p. 682]. This mode depends on a learning procedure by experimentation implying expert individuals who combine tacit knowledge by making them explicit, thus facilitating their communication, their disembodiment and their generalization under the form of invention patents [JEN 07, p. 683]. The second type of learning engages individuals in a process of accumulation of experiential knowledge in and by action and interaction. This type of learning is associated with an innovation mode called "*doing–using–interacting*" (DUI) by Jensen *et al.* [JEN 07, p. 684]. Herstad *et al.* [HER 15, p. 139] indicate that in complex innovation projects, both modes coexist. Together, STI and DUI innovation modes allow us to understand how firms manage the variety of tacit and explicit knowledge mobilized in order to develop innovation (i.e. know-why, know-who, know-how, etc.).

1.2.4. *Innovation capability as dynamic capability rooted in the management of knowledge*

The dynamic capability and the innovation capability of the firm share a certain number of attributes associated with the way in which knowledge is produced and used by the firm. Indeed, if they are not similar to a sub-category of operational competences, the dynamic and innovation capabilities can be divided into sub-categories of organizational aptitudes dedicated to the management of a variety of knowledge types and processes.

Teece [TEE 07] thus consider that the dynamic capability of the firm comprises three types of aptitude:

1) To make sense of the threats and opportunities which are present in the environment (*sensing*).

2) To seize the business opportunities by deploying a strategy which identifies and articulates the required competencies in order to generate value (*seizing*).

3) To reconfigure the available tangible and intangible resources in order to sustain the dynamics of value creation (*reconfiguration*).

In this context, Teece [TEE 07] deems that the integration and combination of knowledge assets is a key competence (*core competence*), thus underlining the decisive role of knowledge management practices. From this viewpoint, the dynamic capability of the firm depends on the combination of generative and interactive knowledge processes. Jyoti *et al.* [JYO 01] identify seven knowledge management processes that allow an impact on the development of the dynamic capability of firms. The seven processes that are frequently implemented by firms to manage knowledge are the sharing, formalization, creation, protection, conversion, use and acquisition of knowledge [JYO 01]. Gebauer *et al.* [GEB 12] particularly suggest that innovation depends on the firm's absorptive capability, the latter being influenced by the interaction between learning processes and the combination of knowledge.

This position implies that the knowledge management processes and the dynamic and innovation capabilities are closely intertwined [CEP 07]. Indeed, the creation and evolution of the firm's dynamic capabilities require the accumulation of experienced knowledge (e.g. by a personalization strategy) as well as the articulation of knowledge (e.g. according to a codification strategy). Calantone *et al.* [CAL 02] identify many factors that have an impact on organizational learning and, by extension, the innovation capability of the firm. The authors especially quote the engagement of individuals toward learning, their aptitude to share a common vision, their open spirit or their capacity to share knowledge [CAL 02]. These factors have a moderating effect on the innovation capability of the firm through the influence they exercise on organizational learning. It then appears that firms' dynamic and innovation capabilities depend on common processes of shared knowledge and learning. These processes underlie not only the transformation of firms' resources and competencies (dynamic capability), but also the invention and commercialization of new products, services and technologies (innovation capability). Michailova and Zhan [MIC 15, p. 576] evoke the notion of *dynamic knowledge capability* to indicate the double-generative and integrative character of firms' innovation capability, as well as the internal and external factors that influence its acquisition, its maintenance and its development.

In this work, we define the innovation capability as a dynamic capability. This innovation capability depends on the combination of operational competencies (i.e. routines, aptitudes and abilities) that the firm mobilizes in order to invent and commercialize new knowledge incorporated in new goods, services, technologies, procedures or organizations (Figure 1.2).

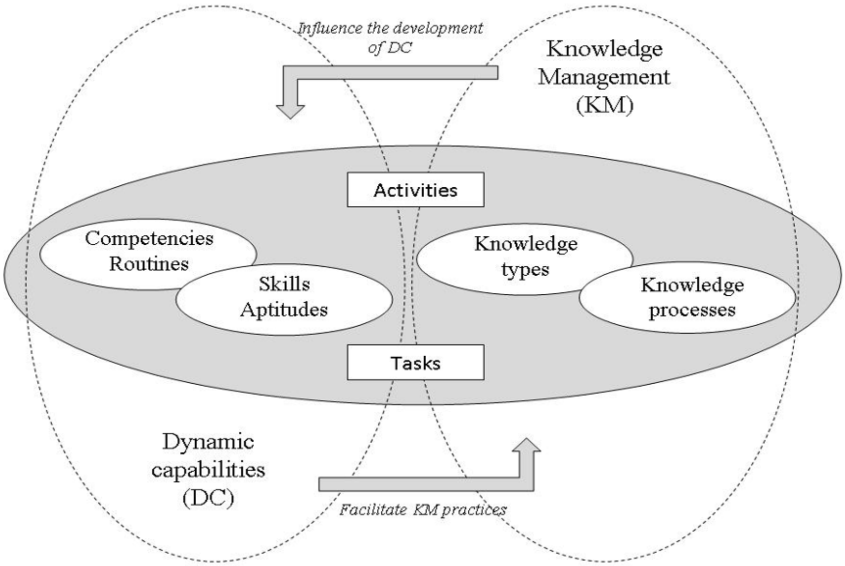

Figure 1.2. *Innovation dynamic capability and knowledge management*

The innovation capability of the firm derives from the management of knowledge types and processes supporting the achievement of tasks and activities relative to the diverse phases and stages of the innovation process. In turn, these management practices influence the development of the firm's operational competencies whose renewal and transformation is based on an organizational learning cycle.

In our opinion, this definition has many merits.

1) First, it allows us to avoid the semantic ambiguities between the concepts of dynamic capability, innovation capability and organizational learning. The innovation capability is, in fact, defined as a dynamic capability that derives from the combination of operational competencies relative to the management of various knowledge types and processes mobilized to innovate.

2) Second, it offers a framework that allows us to articulate knowledge types and knowledge management processes with the tasks and activities performed during the invention and commercialization phases.

3) Third, it enables us to represent the development, evolution and use of the firm's innovation capability as an organizational learning process anchored in the interactive and generative processes of knowledge management.

If we accept the idea that knowledge management processes determine the innovation capability of the firm, then the study of knowledge types and processes becomes necessary to understand how firms innovate. The second chapter of the book specifically explores the processes and types of knowledge mobilized by the firms to innovate, and identifies the knowledge management practices associated with them.

2

Knowledge Typology and Knowledge Processes at the Service of Innovation

Defined as the creation and the application of new knowledge to render it productive [PEN 59, DRU 93, HAT 06], innovation must be "*apprehended as a dynamic process of development of new knowledge enabled by the learning of the innovation collective that engages itself in view of a future success*" [HAB 10, p. 95]. As knowledge itself is defined as a dynamic process, it is a continually recreated and rebuilt flux. As it ensures a competitive advantage, it is a strategic power resource of organizations [BOU 07] whose management features a "*specific systematic and organizational process in order to acquire, organize and communicate tacit and explicit knowledge*" [ALA 01, p. 6]. "*Knowledge management then consists in not only keeping knowledge and to organize access to it, but also, to favor the creation and sharing of this knowledge via the interaction between individuals and the key tools/technologies or technological functionalities*" [KHA 14, p. 56]. This systematic approach to knowledge management enables us to identify many processes demonstrating the manner in which knowledge is managed at the heart of the organization: the creation (or generation), the codification (or stocking), the diffusion (or transfer), the transformation, the application, the integration and the protection of knowledge [BOU 07, CHA 13]. Such a typology of knowledge processes reflects not only the cognitive and social nature of organizational knowledge[1], but also its incarnation in cognition, individual practices, collective practices and culture. Indeed, the organizational memory, the

1 Organizational knowledge is defined as "*the flux composed of experience, values, contextual information and expertise that enable assimilating and evaluating the newly lived experiences and the received information*" [DAV 99, p. 5].

Knowledge Management and Innovation: *Interaction, Collaboration, Openness*,
First Edition. Pierre Barbaroux, Amel Attour and Eric Schenk.

sharing of information and collaborative work are tightly related to the notion of knowledge management [WAN 07].

For all that, such a typology does not allow us to understand how these processes articulate themselves into innovation. Bearing in mind that "*knowledge and innovation are inseparable*" [FID 15, p. 1426], it is pertinent to consider that knowledge management is related to the way in which firms innovate. In order to understand this, it is convenient to identify and show how the different knowledge processes translate into innovation. From this perspective, and in order to go beyond the diversity of typologies of knowledge processes proposed by the literature, we show in this section that the different management processes, studied in an isolated manner by the specialized literature, are interdependent. In other words, innovation depends on dynamic management of three fundamental knowledge processes: the generation, application and valorization of knowledge (Figure 2.1). We will illustrate this dynamic management through the study of a collaborative innovation case [ATT 15]: the platform ecosystem Sophia Zen (see Box 2.1).

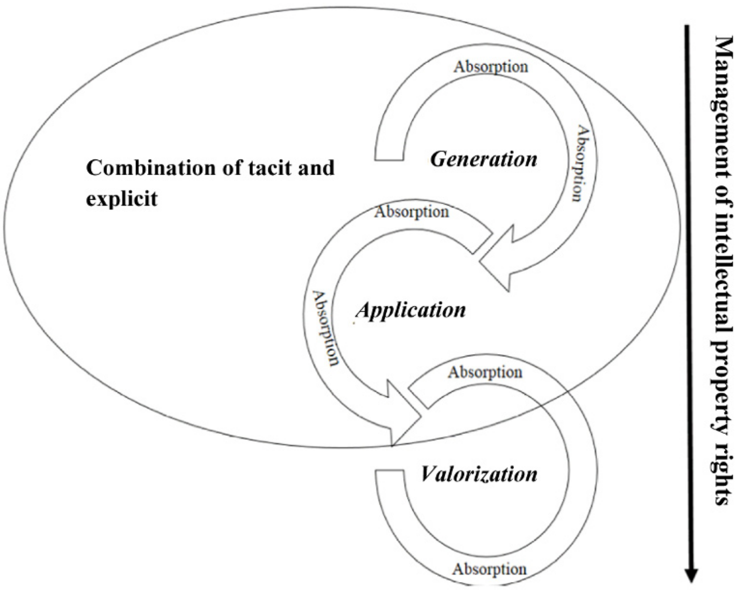

Figure 2.1. *Knowledge management in innovation: a dynamic articulation of the knowledge process*

Characteristics of platform ecosystems [GAW 14]

Platform ecosystems are modular structures in which multiple components, initially independent, are interconnected thanks to a central asset: a technological platform [IAN 04, BAL 09, KOE 13]. The components are carried by different actors who interact in view of developing a technological platform from which to elaborate a commercial offer capable of generating value for all stakeholders. The platform, be it a product, a service, a system or a technology [GAW 10], is the result of a collaborative innovation process. It possesses a certain number of characteristics [GAW 14]. In this way, the platform ecosystems articulate different analysis levels, each indicating a particular organizational context: within the firm, between firms (chain production) and between industries. The actors who compose the platform ecosystem differ according to the context [GAW 14]. Furthermore, a platform ecosystem necessarily depends on a common decomposable architecture (i.e. modular) and is organized around a core and a periphery [BAL 09]. The actors located at the center and those located at the periphery of the ecosystem interact via standardized interfaces. Depending on the organizational context, technological interfaces can be open (industrial platforms), semi-open (chain production-type platforms) or closed (internal platform). Finally, the variety of innovation sources, the nature of the capacities of the actors and the coordination mechanisms change according to the type of platform: an internal platform, a chain production-type platform and an industrial platform. In this way, within internal platforms the variety of innovation sources is limited and coordination depends on hierarchy. In the chain production-type platforms, the variety of sources and the actors' capabilities increase, and the coordination mechanism features the model of the "client supplier" contract. In the industrial platforms, the sources of innovation and the capabilities of the actors are multiple; the governance mechanisms of the leadership type are then privileged.

The Sophia Zen case (in Attour and Barbaroux [ATT 15])

The primary aim of the Sophia Zen project is the deployment of a dynamic carpool service dependent on a technological platform integrating two components called CHEMIN (way) and ENTREPRISE (firm). It demands the cooperation of many actors, especially the informatics services society GFI Informatics[2] (GFI), the University of Nice Sophia Antipolis (UNS), the commuting services network of Sophia Antipolis (Envibus) and the Community of the Urban Conglomeration of Sophia Antipolis (CASA). The first component, CHEMIN (E-guided History Ways for Mobiles Integrating the NFC), proposes a service destined for persons moving around the technical pole of Sophia Antipolis. This first service offer aims to guide these people on a cultural and/or historical journey. It is deployed by the UNS and is

2 Reference European actor in informational services with added value and in software development.

constituted of a multimedia information service (video, audio, photo), received or produced on the individual's mobile phone and a geo-localization service. Different walking and sightseeing options in "virtual" spaces are offered to the final users. The second component, called ENTREPRISE, is deployed by GFI. It is the iPhone app "GPT" (Genevan Public Transport), which displays, in real time, the next bus commuting to the city of Geneva thanks to their exact GPS position. The aim of GFI is to make this solution multimodal by associating with it a geo-localization system identical to the world localization system (*Global Positioning System* – GPS) but specific to the technological pole. It aims specifically at reducing the inconvenience commonly associated with normal GPS, which cannot give an exact position or know the researched area. The ENTREPRISE component offers a solution by upgrading the positions and descriptions of firms (in case of a firm moving to the technological pole of Sophia Antipolis, for example). This second service enables employees as well as business tourists to orient themselves in real time at an activity or firm zone. The platform ecosystem Sophia Zen is thus born from the recombination of two existing technological components, as well as all of the tacit and explicit knowledge, individual and collective, associated with them.

Box 2.1. *The platform ecosystem Sophia Zen (in Attour and Barbaroux [ATT 15] and [ATT 16])*

2.1. Knowledge generation

The generation of new knowledge is a process that features the recombination and integration of knowledge distributed at the heart of a collective view of developing innovation (of a service, a product or other) capable of generating value. In particular, it consists of transforming the tangible and intangible assets of the stakeholders, through the recombination, absorption and integration of preceding and newly created knowledge. Innovation can stem from a preceding grasp of knowledge that needs improvement and development. This process enables creation of two types of knowledge within collaborative innovation projects: *sideground* knowledge, developed during innovation but not being the object of collaboration, and *foreground* knowledge issued from collaboration [GAS 06]. In this way, knowledge can be defined as "*a dynamic process continually reproduced and recreated by the social processes of interaction and practice*" [HAB 10, p. 97]. Built within the action of individuals enrolled in a social network and organizational artifacts [ORL 00], these interactions will then serve as a lever in order to generate new knowledge from existing knowledge [LEO 98]. In other words, the generation of knowledge is a process consisting of transforming general knowledge into specific knowledge [LOP 11]. Such a process articulates two sub-processes – the creation (or combination/recombination of existing knowledge) and the integration of knowledge – within which absorption plays a key role.

2.1.1. *Knowledge creation: a process of combination/recombination of background knowledge*

Strongly anchored in the social, cultural and historical context in which it develops, the creation or recombination of knowledge reflects a subjective reality[3] [NON 94]. More precisely, it concerns a social process generating interactions and the individual and collective learning which, at the same time, sets in motion the creation of new knowledge. Various theoretical approaches have been proposed in the literature to model this knowledge creation process. The most commonly accepted and used is the model of Nonaka and Takeuchi [NON 97], which is grounded in two dimensions. The first is an epistemological dimension, which depends on the distinction between explicit and tacit knowledge:

– Explicit knowledge is formalizable, transferable, can be coded and can take the form of laws, rules, procedures, books, databases, technical competencies, learning and scientific manuals, mathematical formulae, etc. [REI 95].

– Tacit knowledge takes the form of know-how, experiences, automatisms and routines. It is of a non-verbal nature, not articulated, and thus, more difficult to encode and to transfer [POL 66]. Its diffusion has only been possible thanks to shared experiences. In other respects, tacit knowledge as well as explicit knowledge can either be of an individual or a collective nature.

The second dimension is ontological. It refers to the creative entity of knowledge: an individual or a group, one or more organizations. In this way, it is possible to distinguish knowledge being of an individually tacit, individually explicit, collectively tacit or collectively explicit nature [HAB 10]:

– Individually tacit knowledge is a procedural knowledge that needs to be completed by intuitive, practical, relational knowledge. It refers to the "*know-how*" [REI 95].

3 The subjective reality corresponds here to what Nonaka calls "*a justified true belief*" [NON 94].

– Individually explicit knowledge refers to the "*know-what*", i.e. scientific, technical, administrative knowledge, etc. [REI 95].

– Tacit collective knowledge is the set of shared beliefs (common language from a group or organization), collectives (common knowledge associated with the identification process of a group), routines (non-formalized actions inscribed in collective habits), which refer to a certain "*knowing what to do*", or improvizations (capability to experiment solutions so as to reduce or neutralize menaces before moving on to the exploration stage).

– Explicit collective knowledge can take the form of procedures, organizational rules, information systems, databases, documents and books pertaining to the organization [NON 95, REI 95].

The interaction between the epistemological and ontological dimensions of knowledge generates a dynamic (spiral) of knowledge creation dependent on four conversion modes: socialization, externalization, combination and internalization (SECI model) (see Box 2.2 and Figure 2.2). Through this theoretical model, Nonaka and Takeuchi [NON 95] show that understanding of the knowledge creation processes depends precisely on the comprehension of the transformation process operated by two knowledge spirals.

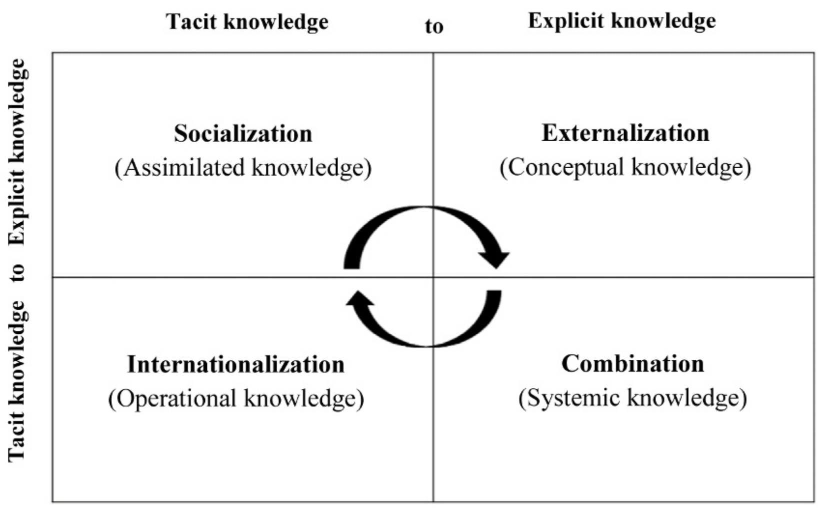

Figure 2.2. *SECI model of Nonaka and Takeuchi [NON 95]: "Knowledge Spiral"*

According to Nonaka and Takeushi [NON 97], the interaction of tacit and explicit knowledge (epistemological dimension) generates a "spiral" of knowledge creation which, in turn, engenders an ontological knowledge spiral (individual–organizational). Innovation emerges from the interaction of these two "spirals" according to four conversion modes.

Conversion Mode 1: socialization

Favored by social interactions and the sharing of experiences, *socialization* (tacit to tacit) consists of converting originally tacit knowledge into new "assimilated" knowledge (shared mental models, know-how, technical aptitudes, etc.). This first conversion mode generally starts by the setting of a team or an interaction domain. So, it can be perceived as a learning process inspired by *behaviorism* [NON 97].

Conversion Mode 2: externalization

Externalization (tacit to explicit) is, on the contrary, a more formalized process, appealing to dialog, metaphor, analogical reasoning and exchanges in the context of a collective. During externalization, the innovation actors formalize the newly created tacit knowledge in order to make it communicable to the collective. This is therefore a knowledge conversion mode from tacit into new explicit knowledge, whose creation has appealed to tools such as communication and codification [NON 91, REI 95]. The knowledge created here, thanks to metaphor and analogy, is of a conceptual nature.

Conversion Mode 3: combination

It is articulated with other existing explicit grasps of knowledge during the "*combination*" mode (explicit to explicit). Indeed, combination refers to a cognitive learning process facilitated by the sorting, categorization, synthesis and classification of knowledge [NON 97: 9]. It creates "systemic knowledge" such as, for example, a prototype or new component technologies.

Conversion Mode 4: internalization

Lastly, resulting from a "*learning by doing*" process [NON 95, p. 91], i.e. learning inscribed in practice and in action, *internalization* appeals at the same time to the behavioral and the cognitive dimensions of learning the aim of turning explicit knowledge into new tacit knowledge (explicit to tacit). This created knowledge is of an operational nature and has an impact on the project management, the production process, the use of new products or the implementation of a policy.

Box 2.2. *The SECI model of Nonaka and Takeushi [NON 95]*

Most often, the triggering element of the knowledge creation process is external to the organization and possesses a strategic aim. It is initiated at the level of the individual to be later transposed to the inter-organizational level. According to [KIN 98], the creation of knowledge is in effect a "*process consisting in creating, absorbing, acquiring and using knowledge to reinforce or improve the performance of the organization*"[4]. In this way, the innovation process (or the creation of new knowledge) can be initiated by an individual (an employee from the organization, for example, a manager, etc.), and then be distributed and developed within the organization to be later exchanged at an inter-organizational level. As it has been made clear by Liu [LIU 12], the individual creates and accumulates (tacit) knowledge that he later shares within the organization through systematic articulation which contributes to transforming its tacit grasp of knowledge into explicit knowledge. This knowledge created individually can take the form of individual research, experimentation, etc., and constitute a "pool" of knowledge creation at an organizational level [LAM 00, MCF 04]. This is because, according to Habib [HAB 10], two other knowledge conversion modes (phases) can be included in the knowledge creation process: scanning and abstraction (see Box 2.3).

According to Habib [HAB 10], the creation of knowledge in innovation is a dynamic process "of development of new representations, concepts or artifacts enabled by the social interactions and mobilization of different types of knowledge" [HAB 10: 100]. Such a process intertwines six phases: scanning, conceptualization, valorization, development, abstraction and distribution. The *scanning* phase consists of extracting pertinent information from the external environment and identifying the idea of innovation. It is composed of many activities (observation, identification and analysis of needs, benchmarking, etc.) that mobilize, confront and articulate explicit collective knowledge (regulations, documentation, book, article, etc.) and individual tacit knowledge (intuitive and relational knowledge). Knowledge created during this phase is of an abstract nature and takes the form of an idea of innovation.

During the phase of *conceptualization*, the actors conceptualize the aims, the perimeter and the different parts of the innovation project through the transformation of tacit collective knowledge into communicable explicit knowledge. For this, they proceed to opportunity and feasibility studies in a more formalized manner than during the scanning phase. The knowledge created as a result of this phase is a

4 "The process by which an organization creates, captures, acquires and uses knowledge to support and improve the performance of the organization" [KIN 98, p. 2].

common type of knowledge, at the same time explicit (group work) and tacit (reinforcement of shared beliefs).

During the phase of *valorization***,** actors seek to legitimate innovation in the eyes of different stakeholders (the organization and its environment). The concept of innovation must then be distributed at the exterior of the innovation collective.

In the *development* phase, the knowledge creation process is identical to the conceptualization phase: articulation and codification of tacit collective knowledge in explicit knowledge incarnates explicit knowledge that embodies the concrete development of innovation (prototype, model, showcase, production start-up, etc.).

Explicit knowledge is later exploited during the phase of *abstraction*. The exploitation of concepts and artifacts defined during the ulterior phases here contributes to creating new explicit knowledge for which the individual tacit knowledge from the innovation actors plays a key role.

Lastly, in the distribution phase, the actors recombine the explicit knowledge related to innovation, i.e. they reorder the artifacts and distribution modes of innovation. For this, they mobilize their individual and collective tacit knowledge (know-how). This phase characterizes a progressive exit from the innovation process that leaves place to a collective work in charge of commercializing or deploying innovation in and/or at the exterior of the organization.

Box 2.3. *The process of knowledge creation in innovation according to Habib [HAB 10]*

Ultimately, the knowledge creation process is tightly related to the process of sharing and distributing background knowledge. Background knowledge and the motivation associated with their combination constitute the triggering element not only of the process of knowledge generation but also of the mechanisms and sub-processes that underlie them. In the case of the platform ecosystem Sophia Zen, for instance, we observe that the knowledge generation process was first initiated within the UNS in order to be later pursued with GFI (Box 2.4). Moreover, observation of this case shows that the absorption capability of the actors [COH 90] plays an essential role not only in the knowledge generation process but also, as we shall see in the following paragraph, within the knowledge integration process.

The development of an ecosystem, in terms of innovative organizational form, depends on many phases: birth, expansion, leadership (maturity) and regeneration (or decline) [MOO 96]. The birth phase involves performing activities featuring different stages of the invention phase from the innovation process. The birth of a business ecosystem is thus defined as an "*ideation*" period [MOO 93], which focuses on testing a concept ("*proof of concept*"; Moore [MOO 06]) capable of offering an alternative to existing goods and services, or to open a new market or to generate value. In the case of the Sophia Zen platform ecosystem, this ideation phase is related to a socialization phase in the form of a *brainstorming* session between the different members of a research center from the MBDS Masters program of the UNS (three project managers and a scientific head). The aim of this phase was to identify how to answer a call for bids published (PacaLabs) by the region of Provence-Alpes-Côte-D'azur (PACA). The scientific head's idea was to gather the project managers engaged in the deployment of a previous version of the CHEMIN platform in order to exchange in a way that allowed them to combine and enrich the result of the first experiments conducted in the cities of Nice, Menton and Grasse. With this aim, during the *brainstorming* session, the project managers essentially exchanged the acquired knowledge in the preceding projects they were respectively involved. This knowledge here takes the form of shared beliefs, collective knowledge and development routines of web interfaces and NFC applications. This sharing of tacit collective knowledge allowed identification of the idea to be exploited in the framework of the Sophia Zen project: to unify the different versions of the CHEMIN platform and to enrich it with a geo-localization service making it possible to solve the traffic jam problems existing at the technical pole of Sophia Antipolis. Knowledge sharing was later followed in the framework of everyday activities of the project managers and succeeded by an email exchange or dialog on the occasion of meetings that followed the brainstorming sessions. At the end of this ideation phase, new concepts were then created and interiorized by the "*knowing-what-to-do*" of the team. Leading to a new externalization phase, where the dialog and the exchanges continued with the GFI partner, the mobilization of this knowledge was essential during the birth phase of Sophia Zen. Indeed, the entry of the GFI actor in the innovation process of Sophia Zen generated a new knowledge loop or knowledge spiral (in the sense of Nonaka [NON 94]), allowing the two actors to learn through the dialog and exchange in a manner in which they may share their (tacit and explicit) knowledge, to combine the CHEMIN component with the ENTREPRISE component.

Box 2.4. *The generation of knowledge at the heart of the Sophia Zen ecosystem [ATT 15]*

2.1.2. *Absorption and integration of knowledge*

Representative of the learning potential of a collective or individual entity, with the intention of adapting to a market or achieving a competitive positioning, the absorption capability is defined as an organizational learning process [COH 90]. For Zahra and George [ZAH 02], the absorption capabilities are a set of routines and organizational processes, which enable production of an organizational dynamic capability. According to Daghfous [DAG 04], they depend on internal factors (background knowledge – or previous knowledge bases, individual absorption capability, transfunctional communication and organizational culture) and external factors (external knowledge environment and position in the knowledge network). It appears that the absorption capabilities, previous knowledge, transfer mechanisms and organizational mechanisms are tightly connected. In the literature, we distinguish two precedents of absorption capability [COH 90, VAN 05]: the previous knowledge pertaining to the knowledge domain to be transferred (general knowledge of associated domains, basic aptitudes and problem resolution methods, a previous learning experience, a shared language, etc.) and the internal organizational mechanisms that influence the absorption capability of an organization, for example, the intra- and inter-organizational communication structure.

More precisely, it is through collective explicit knowledge by which an organization learns, acquires, assimilates, transforms and exploits knowledge with the aim of adapting to the environment variations and providing itself with a competitive advantage [ZAH 02]. The role of absorption capability within the knowledge generation process can be analyzed through four of its dimensions – the acquisition, assimilation, transformation and exploitation – each of them constituting a dynamic capability as abridged in Box 2.5 [IMB 12]. For Zahra and George [ZAH 02], these four dimensions make it possible to distinguish the potential absorption capability from the already performed absorption capabilities. The first dimension includes the acquisition and assimilation capabilities of the organization. Triggered by events related to change, experiences or the need to combine complementary (or different) knowledge, these potential capabilities have an influence on the performed capabilities via formal and informal social integration mechanisms. These performed capabilities are composed of transformation and exploitation capabilities.

Absorption capabilities are defined as being a learning process composed of four dimensions.

Acquisition: an identification and external information evaluation capability

Depending on background knowledge [NOB 10], acquisition is defined as the aptitude to recognize, value and acquire external information essential to the operations of the firm [ZAH 02]. It depends on three components: the previous investment (risk tolerance, hierarchy support, investment on R&D), the preceding knowledge (basic knowledge, experience from the R&D service, last diploma, knowledge of the components of a product or system[5]) and the motivation to share knowledge (to recognize value, engagement and motivation, intensity and speed).

Assimilation: a capability to apply external knowledge

Assimilation sustains itself on the capability of the organization to absorb external knowledge. It "*makes reference to the routines and processes of the firm that allow the analysis, interpretation and understanding of knowledge coming from external sources*" [ZAH 02, p. 189]. Assimilation allows us to surpass the difficulties caused by the acquisition of external knowledge and particularly knowledge rooted in a specific context that can make interpretation and transformation difficult. Assimilation then features the confrontation of internal and external knowledge and interpretation [NOB 10, IMB 12].

Transformation: an internalization capability (i.e. extension of the basic knowledge of the firm)

Transformation makes reference to the integration of knowledge and can take the place of a recombination of already acquired knowledge. It highlights the "capability of an firm to develop and refine the routines that facilitate the combination of existing knowledge with the newly assimilated knowledge" [ZAH 02, p. 190]. It depends on the internalization and contextualization of knowledge, which involves re-encoding, questioning and integration. In fact, the activity of transforming knowledge presupposes the existence of processes contributing to reorganizing and changing the knowledge structures in force in the firm [ZAH 02].

Exploitation: a knowledge integration capability with commercialization aims

For Cohen and Levinthal, the exploitation of knowledge features the capability of individuals belonging to an organization (employees) to apply new external

5 See section 2.2 for a definition of components of knowledge.

knowledge with commercialization aims. The approach of Zahra and George [ZAH 02] favors an approach centered on learning. This approach considers that exploitation depends "*on the routines that enable the firm to refine, to extend and to exploit the existing competences or to create new ones integrating the acquired knowledge and the one transformed in the production process*" [ZAH 02, p. 190]. The exploitation is then embodied by all processes and routines that underlie the integration of new knowledge in products and services [VAN 99]. In other words, it reflects the firm's capability to use and implement external knowledge.

Box 2.5. *The absorption of knowledge, a capability of four dimensions [ZAH 02, IMB 12, NOB 10]*

In concrete terms, resorting to absorption capabilities can be triggered, for example, in the framework of common experimentation or a collaborative innovation project. In this context, the exchange of background knowledge between two or more actors initiate coordination mechanisms that, in turn, mobilize relational capabilities of knowledge sharing. Among the triggers of a knowledge absorption sequence, we distinguish equally the links established with the external knowledge sources and the combinational capabilities, for example the habit of working in teams and taking part in decision-making [IMB 12]. In fact, absorption and, more generally, the efficacy of the knowledge generation process, depend on dialog and formal and informal exchanges, i.e. on social interactions (socialization) materializing through many mechanisms such as meetings, *brainstorming*, social networking, experimentation, *story-telling*, etc. These tools, which we qualify as knowledge management mechanisms, enable innovators to place their newly acquired knowledge (created from explicit knowledge) in an interactive scenario (Box 2.6).

After GFI entered into the Sophia Zen project, the process of knowledge generation mobilized the knowledge relevant to the functioning of the components CHEMIN and ENTREPRISE, as well as the manner in which it is possible to connect them. The aim was to formalize methods of connecting the routines of use and organization of knowledge into two components. The sharing of knowledge was then operated through different communication channels: a brainstorming session, two work meetings between the project managers of the UNS, the project manager and director of GFI-Sophia Antipolis, and the email exchange between the two teams. The exchanged knowledge during this phase consists of technical knowledge (acquired during preceding experiences) related to each of the components of Sophia

Zen, the shared beliefs in the innovation contexts to explore and the market opportunities to which the development of one or more components of CHEMIN or ENTREPRISE could enable access to (especially the dynamic carpool market).

Box 2.6. *Absorption and integration of knowledge at the heart of the Sophia Zen ecosystem (in Attour and Barbaroux [ATT 15] and [ATT 16])*

In summary, knowledge generation can be defined as a process of converting tacit knowledge into explicit knowledge via social interactions, which take place during moments of shared experiences [NON 94, NON 95, NON 03]. This tacit knowledge can itself be acquired by sharing experiences outside the innovation process (informal discussion between two individuals sharing leisure time, for example). As defined by Tyagi *et al.* [TYA 15], the creation of knowledge is a "*process consisting in continually feeding or upgrading the basis of the recently acquired, accessible and usable knowledge*[6]". It is therefore a process consisting of analysis, combination and absorption of existing knowledge resulting in generation of new knowledge, which will become the object of recombination (see Figure 2.3).

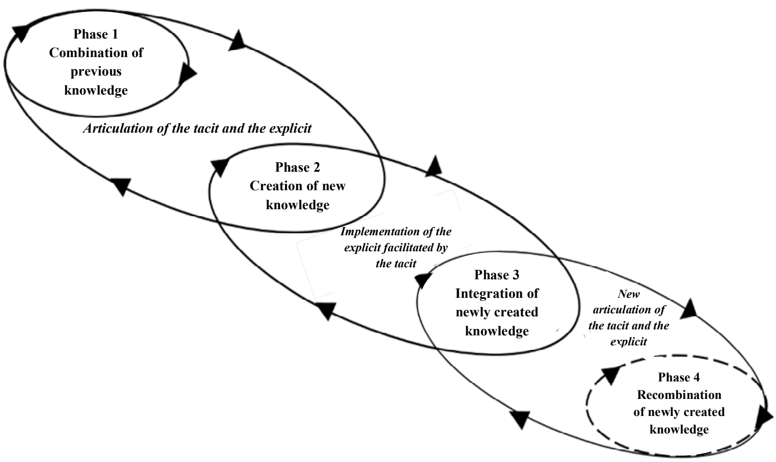

Figure 2.3. *Generation of knowledge within the innovation process*

6 Knowledge creation is defined as "the process of continuously updating or increasing the knowledge base of what one knows now, rather than what one didn't know before, and keeping it accessible and usable" [TYA 15, p. 205].

More precisely, the generation of knowledge is a process consisting of four phases (combination and recombination of previous knowledge, and creation and integration of new knowledge), which may engender the last (fourth) phase: the recombination of knowledge. Within this process, the absorption capability governs the dynamics of interdependence among the different phases that characterize it. This central role of the absorption capabilities is even more important when the knowledge generation process is set in a collaborative innovation context. As the importance of resorting to knowledge external to the organization increases, its absorption capabilities increase. The organizational performances [HAM 89] and the innovation capabilities of the organization are reinforced.

Apart from facilitating the articulation dynamics of the different phases in the knowledge generation processes, the absorption capabilities play an equally crucial role in the application of external knowledge process.

2.2. Knowledge application

Knowledge application features the alignment of knowledge generated individually and/or collectively by the stakeholders of innovation. It depends on the equilibrium between sharing (or exchange) and coordination of three types of knowledge whose articulation contributes positively to the invention: technical knowledge, organizational knowledge and knowledge related to innovation business models [REI 14]. More generally, the application of knowledge derives from intellectual and social alignment of knowledge. In this framework,

– *the intellectual alignment of knowledge* indicates the congruence level between the technological, organizational and business dimensions of components (or artifacts) of an innovation [REI 14, p. 592][7].

– *the social alignment of knowledge* represents a vision shared by the technical, commercial and organizational direction teams [HE 07, LEV 01].

7 Knowledge alignment is "*the shared understanding between the IT, business and governance teams and congruence between the artefacts that represent knowledge of IT, organizational and business processes, and business value*" [REI 14, p. 592].

In concrete terms, these two sub-processes appeal to mechanisms of knowledge strategic management: codification and personalization [REI 14]. We shall see in this section that, being defined as alignment processes, these mobilize specific knowledge processes called architectural knowledge.

2.2.1. *Codification and personalization: two complementary strategies of knowledge alignment*

The aim of the application process is to link individuals and organizations in possession of knowledge with other individuals or organizations that need this. The application of knowledge thus embodies the way in which knowledge is exchanged, shared, and distributed between a source and an addressee. For this, knowledge must first be standardized, that is to say, structured in a set of interrelations and identifiable rules facilitating communication and sharing [KOG 92]. In other words, it must be the object of *codification*, making explicit and articulating knowledge in a way so as to express it according to a certain language and to inscribe it on a data carrier [DAV 02].

Information and communication technologies (ICT) are a key tool of knowledge codification [ALA 01] and take the form of knowledge management systems (KMS), which are categorized into two groups. We distinguish between the technologies allowing for the stocking of individual and collective knowledge under the form of structured documents (knowledge basis) from those facilitating the interactions thanks to collaborative tools based on ICT [KHA 14]. In this way, we distinguish the knowledge codification processes mobilizing integrative technologies from processes that privilege interactive technologies [ZAC 99]. When it mobilizes integrative technologies, the codification process consists of net-disseminating knowledge under the form of objects such as databases, information systems, etc.

Availability and access speed to codified knowledge responds to a value creation logic founded on reuse ("reuse-economics") [EAR 01, HAN 99, JAN 08]. Knowledge is then apprehended as a formalizable "object" (*knowledge*). Concretely, the codification process consists of turning individual knowledge and information possessed by an organization into organizational knowledge [PER 11]. In other words, it is about distributing tacit (or explicit) knowledge previously translated into explicit knowledge. In this case, the codification process has a technical/instrumental aim [COO 99, ALA 01] "*in transforming the knowledge possessed by individuals into an object with the help of processes and codification tools*" [PER 11, p. 117].

When mobilizing interactive technologies, the knowledge codification process is more centered in interaction (*knowing*), the behavior of actors and, therefore, knowledge "in action" [EAR 01]. We talk about knowledge *personalization* [EAR 01, HAN 99, JAN 08], in which codification focuses on the individual and expertise ("expert-economics"). Contrary to technical codification processes, *personalization* responds to a reciprocity logic based on existing social ties between the individuals and not on a knowledge "dispossession" logic [HAN 99]. The source of value here is interpersonal communication, i.e. the exchange of tacit knowledge. The stress is placed on dialog, interpersonal exchange and thus socialization by the development of collaborative work spaces, for example. As they are the property of the individual and strongly anchored in a social context, tacit knowledge (e.g. the practices co-built by a group of individuals) is difficult to codify and transfer [GHE 00, PER 11]. As described by Orlikowski [ORL 00, p. 253], "*if the practices are defined as the contextual recurrent activities of human agents, then they cannot be distributed as if they were stable and static objects*". Codification *stricto sensu* is smaller in this case. The KMS no longer acts as a tool incarnating/stocking knowledge, but as a tool that connects individuals. They take the form of interactive technologies, for example the collaborative a-synchronistic tools (the *groupware*) or synchronic tools (the *messenger*).

As summarized by Janicot and Mignon [JAN 08, p. 98][8], the resort to one or other processes of knowledge alignment – personalization or codification (see Table 2.1) – seeks to satisfy, respectively, a business strategy or a pure knowledge management strategy (see Table 2.2).

8 From the works of Hansen *et al.* [HAN 99] and Lowendahl *et al.* [LOW 01].

	Codification	Personalization
Model	Reuse, knowledge stock, distribution	Expertise, customization, asset specificities
Knowledge nature	Formal, explicit and non-personalized	Tacit, interpersonal, preferably informal
Strategic allocation of resources	Development of a knowledge stocking and distribution system	Acquisition by engagement of new expertise, investment on inter-firms relations
Missions' dominant nature	Standardized, reproducible	Specific, unique
Knowledge management system	Database networks, electronic treatment of documents, capitalization technologies	Little developed, aid system to interpersonal communication, emails, phone conference, video conference
Role of IT	Central	Secondary
Knowledge transmission	Combination	Socialization, brainstorming
Sources of value creation	Speed, availability, multiuse, cost and delay reduction Value tied to the duration of the service	Adaptation to the mission, expertise quality, margin increase Cognitive value of service

Table 2.1. *Characteristics of knowledge codification processes (Adapted from Janicot and Mignon [JAN 08, p. 98])*

Aim of codification	
Business *[DAV 98, MAI 07]*	Knowledge management *[DAV 98, EAR 99, MAI 07]*
Cost and risk reduction Quality increase, customer satisfaction and productivity Cycle reduction Acceleration of innovation speed Development of new fields	To create knowledge directories To identify and facilitate knowledge access To improve the knowledge environment To share knowledge in a more efficient way through processes To conceive and settle techniques and processes to create, safeguard and use the identified knowledge

Table 2.2. *Aims of knowledge codification (Adapted from Mignon et al. [MIG 12])*

As a conclusion, the application of knowledge depends on a "*stocking process, indexation, distribution of formal knowledge*", i.e. codification

[JAN 08, p. 6], being embodied by many objects: a piece of writing or a mathematical model, a graphic, a list, a board, a database, reports or scientific books, etc. These objects represent, in turn, possibilities of creation of new knowledge [GOO 77] and are only possible when the problem of representation and exchange/sharing/distribution of knowledge presents itself.

2.2.2. *The role of architectural knowledge in the process of knowledge alignment*

Henderson and Clark [HEN 90] argue that, to succeed with the exchange and distribution of knowledge in innovation, it is convenient to master and use the innovation component-related knowledge. Knowledge of components and the manner in which they are related then constitute the architecture of innovation. According to Henderson and Clark [HEN 90], the innovative combination of many existing components is an architectural innovation that implicitly depends on specific knowledge about the components of a system and about the manner in which these are related to one another [BAL 06]. In other words, innovation, be it in the form of a service, a product or a technology, depends on the architecture including a list of functions and necessary components, and a technical description of the functioning of innovation [WHI 04]. Consequently, architectural knowledge comprises knowledge related to the functioning of a system, its planned or unplanned behavior in different environments, and the manner in which the components of this system are interconnected (i.e. the interfaces that relate the components, for example). It is therefore a question of background knowledge that includes routines and organization of knowledge components [TAL 04]. This knowledge is firmly rooted in existing structures and procedures, developed and enacted in the framework of an innovative process combining many markets and heterogeneous technical elements [HEN 90]. In this way, they provide a competitive advantage because of the uniqueness of the product architecture they propose. As it has been shown by Henderson and Clarck [HEN 90] through the example of the photolithography industry, the management of architectural knowledge participates in the construction of the innovative capability of a firm. To favor innovation, but mostly to satisfy the strategic aims of the stakeholders, it is necessary to master the architectural knowledge of the component that will be the object of innovation (by combination, transformation or other).

According to Baldwin and Clark [BAL 06], in this context, the development and exchange of architectural knowledge need:

– to dispose of a cartography of all of the functions of innovation;

– to identify the components of innovation and their interactions;

– to know how the potential change of a component or its interactions impact on the performance of innovation or of its system.

These three prerogatives intervene from the invention (ideation) phase of the innovation process (Box 2.7).

The knowledge generation process that characterizes the birth phase of Sophia Zen depends on the sharing of background knowledge corresponding to each of the ecosystem's actors. Initially, the exchange of previous knowledge was made within the UNS, between the three project managers engaged in the project. From their shared beliefs and interpretation diagrams, they committed themselves to mapping all of the functions developed in the different versions of CHEMIN to identify what changes can operate in their system, on the one hand, and to articulate the rules and procedures formalized in the preceding versions of CHEMIN on the other hand. Likewise, GFI committed to mapping all of the functions of the "**Genevan Public Transport" iPhone solution in order to identify how to make this solution multimodal** and how to associate it with a geo-localization system.

Box 2.7. *The prerogatives related to the exchange of architectural knowledge during the birth phase of the Sophia Zen ecosystem*

In the case of inter-organizational innovation, the association of knowledge concerning related components corresponds to a collective action of two or more firms belonging to different markets. According to Andersson *et al.* [AND 08], architectural knowledge features, in the framework of collective innovation, the combination and the alignment of many strategic and technological elements. Their development depends on a collective process of negotiation implying not only public and private actors, but also users and clients, who integrate the innovation process because of the technical capabilities they hold, their knowledge basis and the market opportunities to which they are capable of opening themselves. This architectural knowledge is apprehended through four dimensions related to the following capabilities [AND 08]:

– Perception of the actors of base functionalities of a component. The recognition of technological capability is governed by the previous experiences pertinent to the components of the architecture.

– Comprehension of the context in which a specific basic component is deployed, i.e. being conscious that many innovation contexts exist and can be mobilized.

– Comprehension of the business model, i.e. the appreciation of market opportunities enabled by the applications of a component.

– Linking, here referring to the resources and competencies mobilized and engaged in a collective effort process to favor the quality of relationships and information exchanges between firms [VAN 05].

These four dimensions enable study of the necessary conditions for the conception process of inter-organizational innovation. They are imperative to the creation of exchange spaces within which the heterogeneous actors meet and negotiate the linking (alignment) of their technologies [KEL 06], as illustrated by the Sophia Zen case (Box 2.8).

The effective combination of explicit knowledge is performed during the expansion phase of the ecosystem Sophia Zen. It is operated by improving the respective components of UNS (CHEMIN component) and of GFI (ENTREPRISE component), as well as their connection. Formerly, during the birth phase, actors first proceeded to identify the possible transformations of each component (technical capabilities proper to each actor). For the UNS, thanks to the experience of each project manager engaged in the previous three versions of CHEMIN, it was a question of mapping the existing functionalities as well as the possible extensions with the aim of evolving certain components (be it for solving the existing technical problems or for the sake of innovating) and to add new functionalities (*technical capability and understanding of the context*). For GFI, the aim first consisted of determining whether it is possible to make the existing “TPG” platform inoperative and to enrich it with new functionalities (*technical capability and understanding of the context*). After that, the connection between the components of Sophia Zen (CHEMIN and ENTREPRISE) needed the mutual assimilation of knowledge (through knowledge absorption), respectively, created by UNS and GFI when the two components were developed. This stage required each of the actors to redefine the technical architecture of their respective solution. From this perspective, the actors mobilized two architectural knowledge dimensions relative to their own component: *understanding capability of the business model and linking capability*.

In order to secure the knowledge exchanges between UNS and GFI, it was necessary to define two distinct exchange zones, allowing the two actors to co-develop and share common architectural knowledge while at the same time preserving the possibility for GFI to provide itself with a competitive advantage over the intention of placing CHEMIN in open source license. The architectural knowledge developed here featured relational competencies, allowing us to solve conflicts elicited by the evolution of the CHEMIN component in open source mode.

Box 2.8. *Knowledge mobilization during the birth phase of Sophia Zen*

The application of knowledge goes through:

– the codification of knowledge: facilitated (or materialized) by ICT, codification transforms tacit knowledge into explicit knowledge, community-based for the congruence between knowledge grasps, be they tacit or explicit, and so contributes to generating new knowledge;

– the combination of component knowledge taking the form of architectural knowledge.

In order to secure collaboration and exchange with external partners in the case of inter-organizational innovation, knowledge management, whatever be its nature, is strongly tied to the management of intellectual property rights.

2.3. Knowledge valorization

Knowledge valorization constitutes the third category of knowledge processes at work in innovation. This category proceeds from the implementation of knowledge management strategies aimed at the protection of intangible assets deployed by the actors and the appropriation of the generated value by the commercialization of the innovation. Collaborative innovation presupposes, from the upstream phase and for all the other phases of the innovation process, the explanation of the knowledge exchange conditions between the different stakeholders. The questions relative to protection and, therefore, to the management of intellectual property rights (IPR) associated with knowledge being the object of exchanges between the partners are considered essential. In the same way, for innovation relating to the creation and transformation of preceding knowledge mobilized by the actors, the questions related to protection must not only refer to the latter but also to the knowledge created during the collaboration and/or being born from the collaboration. As shown by Gassman and Bader [GAS 06], the IPR is at the heart of the problems related to the management of three types of knowledge: *background* knowledge (knowledge developed before the collaborative innovation), *foreground* knowledge (knowledge issued from the collaboration) and *sideground* knowledge (knowledge developed during innovation but not having been the object of collaboration). It is a question of determining how to protect the knowledge that is not part of the collaboration and how to regulate the questions of sharing results from collaboration. Every collaborative innovation process thus leads to the question of how the generated, then spread and later commercialized knowledge is protected not only during innovation, but also by innovation. Besides, this enables us to deal with the problem of exploitation of knowledge, be it of the *background*, *sideground* or *foreground* type. Within collective innovation projects, the management of intellectual property, as knowledge object needing a management effort, plays an essential role in the innovation process [PÉN 13, AYE 16], and particularly concerning the articulation of the different phases of innovation [ATT 15].

Defined as the entirety of exclusive and privative rights accorded over intellectual creations, intellectual property features two dimensions. The first is relative to literary and artistic property (authors' rights, neighbor rights and rights of database producers). It is born from the sole fact of creation. The second concerns industrial property and claims the accomplishment of administrative formalities to benefit from legal protection. The second dimension concerns specifically the rights ruling industrial innovation (inventions, patent's rights, drawings and models, vegetal extracts, topographies of semi-conductors in the domain of microelectronics, know-how[9]) and the rights ruling over distinctive signs (trademarks, commercial names, social denominations, emblems, Protective Designations of Origins, etc.). Whatever the juridical regime of intellectual property rights appropriation (see Box 2.9 for a definition), the yielding of these rights is generally translated through the use or exchange of the ordered sharing of creations among different types of commercial or industrial partners. It allows its proprietor to exploit the commercial value of the fruits of his invention.

9 It should be noted, however, that the know-how is not considered the object of a privative right, but can be included in this list according to Le Loarn and Bianco [LE 09, p. 301].

The appropriation regimes of innovation protect the nature of technology and its legal instruments. The nature of technology spans the dimensions of products, processes and the characteristics of the competencies possessed by the firm (tacit and articulate). The legal instruments refer to the national juridical regime of intellectual property rights. These rights and the jurisdictions capable of making pronouncements in the disputes that these rights might generate are territorial (most often, national). Practically all the countries in the world have their own national juridical regime of intellectual property rights. In Europe, there exists a community-based right of intellectual property, and a certain number of treaties and conventions provide an international framework to IP under the influence of two international administrative institutions: the World Intellectual Property Organization (WIPO) and the World Trade Organization (WTO).

Box 2.9. *The appropriation regimes*

Two instruments of protection and valorization of knowledge play an essential role in the innovation processes: the patents and the cooperation agreements. Moreover, we shall underline the inciting or dissuasive power of these protection instruments in the matter of innovation.

2.3.1. *Patents: protection and knowledge management instruments*

Among the different instruments of intellectual property, the invention patent, a key tool of the protection of technologies and industrial inventions, occupies a central position in the innovation and knowledge management process. By definition, the invention patent is an instrument of juridical protection consisting of writing, recording and defending the rights of a part and to the other part, to "*grant, under certain conditions, a legal monopole of the exploitation of the invention of its author. The latter shall be the only one in possession of the right to exploit their invention and will be able to include the research costs in the sale price, or to demand a remuneration on behalf of other users (patent cession or license contracts)*" [GUE 94, p. 84]. It is an instrument frequently used (and largely studied) to codify the whole of the exclusive rights granted over the exploitation of an invention.

Exploitation features the valorization of property rights. By definition, it includes the creation of value linked to the exploitation of patented knowledge.

Four essential elements characterize the invention patent [PÉN 13, p. 30]:

– The patent is a yieldable right granted for a period of 20 years by the government over an intangible useful intellectual creation. It grants the owner of this legal property right the *right to exclude* all other parties from the possibility of making profit from it (feature no. 1). In other words, it is prohibited to anyone to use the good represented by this intellectual property with commercial purposes without the previous consent of the holder of the intellectual property right. This right to exclude (or privative right) aims to protect the holder of this right from any counterfeiting risk, be it counterfeit associated with the mentioned patented invention or counterfeit associated with the use of patents held by third parties in the process of innovation of the patented invention. The patent is therefore a negative right which allows the organization of the property right distribution among the different stakeholders of a new, non-evident invention, which features an industrial application. It must not be mistaken with the use right.

– The costs associated with invention patents are often long and expensive (feature no. 2). The detection of potential or existing counterfeits supposes massively investing in the activities of economic intelligence and of technological watch. In the same way, having our rights respected when a counterfeit has been detected is equally expensive and long. It requires summarizing a court whose procedures are long and administratively complex.

– Paradoxically to its protection function, the invention patent imposes renunciation of the secret. Every deposit or invention patent in effect needs a detailed description of the invention that will be the subject of a publication via the Internet (and freely accessible) eighteen months after the first demand. The invention patent is therefore a precious knowledge codification tool that supposes transforming tacit knowledge into explicit knowledge (feature no. 3).

– Finally, the invention patent is an instrument which allows organization of the distribution of the value created among the different stakeholders of innovation (feature no. 4). The commercial exploitation of an invention patent is done by giving a license (the patent becomes in this case the object of rent), or by technological transfer materialized in the sale. In case of rent, the holder of the patent authorizes a third party – the licensee – to exploit this right according to the terms defined by a previously established contract in return for a license fee (*royalties*), even possibly an initial payment (*up-front payment*). Pure ideas and concepts not being patentable [PÉN 13], only explicit knowledge, formal and architectural, of the *background*, *sideground* or *foreground* type can become the object of juridical protection.

Through these four characteristics, we find three key activities that define the patent functions: the generation, the protection and the exploitation of intellectual property. These activities are summarized by Reitzig and Wagner [REI 10] thanks to the concept of patent chain value (see Figure 2.4).

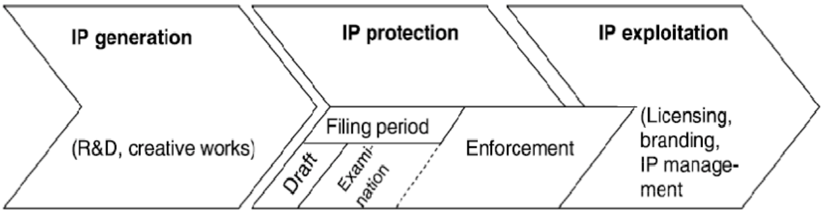

Figure 2.4. *The activities associated with the management of patents [REI 10]*

Apart from the main functions of protection and exploitation of the invention, the concept of patent chain values allows us to underline the patent role in the generation process[10] and knowledge valorization. Knowledge protection and exploitation activities (or industrial property associated with this knowledge) constitute the essential stakes of the valorization process. As explicit knowledge stock (feature 3), allowing for the accumulation of technological knowledge via an obligatory distribution [AYE 16], the invention patent is an instrument that takes part in or facilitates the knowledge generation process. Apart from technological or strategic knowledge, it is necessary for that to appeal to another knowledge

10 Reitzig and Wagner [REI 10] discuss about the generation of industrial properties.

category: juridical knowledge [AYE 16]. Qualified for “contractual support”, this juridical knowledge is essential when agreements with third parties must be defined. It is particularly the case when the knowledge generation process is inscribed in a collaborative innovation context. Juridical knowledge is essential in activities associated with protection and different stakeholders must equitably and necessarily mobilize strategic knowledge to determine the appropriation regime of the innovation.

In the matter of knowledge valorization, the role of juridical knowledge is limited, on the contrary, to the management of contracts with third parties and ensures an “industrial property agreement” function [AYE 16]. Indeed, strategic and technological knowledge is mobilized more in the activities associated with valorization. According to their internal or external nature [AYE 13], valorization activities elicit the problem of exploitation in a different way. Internal valorization is the possession of the holder of the invention. It is connected to the question of exploitation freedom. External valorization concerns the commercial exploitation of the patent. It is translated by strategic choices that deal with the question of arbitration between the cessions of rights (patent sale) or access right (license concession) up to different complex agreements (cooperation agreements in R&D, joint ventures with technological aims, etc.). Internal and external valorization both elicit the question of maintenance (and its finality) and the means of patent use.

Ultimately, patent invention is an instrument that facilitates knowledge generation that mobilizes, in turn, previous knowledge of a technological, juridical and strategic nature (Table 2.3). The alignment of this knowledge with the different activities associated with the patent chain of value is a prerogative of the valorization process. In effect, beyond these three main functions (generation, protection and exploitation of IP), the patent invention constitutes at the same time an instrument of protection and of securitization of knowledge exchange in the innovation processes. They intervene at the upstream phase of the innovation process, favoring the collaborations and non-marketable interactions between the actors of innovation [HAG 12]. During this phase, the cooperation agreement is a complementary tool to the invention patent.

Activities associated with the patent chain value		Mobilized and articulated knowledge		
Stages	Aims	Technological	Juridical	Strategic
Generation	Development of knowledge, some of which will be protected by a patent	Development of technological knowledge in the form of a source of competitive advantage over the core of the profession (differentiation)	Juridical knowledge in terms of “support” or “intellectual property agreement”	Knowledge associated with the general strategy (adequacy general strategy/innovation strategy)
Protection	Choice of juridical protection by patent or not/ Recording and defense of rights	Weak implication of technological knowledge (limited to writing, especially of vindications)	Juridical knowledge “core of profession IP”: deposit, vindications, recording, exploitation freedom, rights exercise	Knowledge associated with strategic implications of protection choices (patent or not)/Knowledge associated with deposit and extension zones
Exploitation	Effective valorization of patents (internal and external valorization)	Development of technological knowledge as valorization of generated innovations (lifecycle prolongation, research of external valorization)	Juridical knowledge “support” or “intellectual property agreement”	Knowledge associated with the choice of valorization modes, to potential income sources in the interior or at the margin of the core of the profession

Table 2.3. *Alignment and knowledge types within the valorization knowledge processes (adapted from Ayerbe [AYE 16])*

2.3.2. *Cooperation agreements: instruments of anticipation of knowledge management strategies*

The second instrument ensuring a function of protection and knowledge valorization is the cooperation agreement. It is a legal document that enables us to clarify from the upstream phase of innovation the use conditions of different types of knowledge mobilized and created by innovation. During this upstream phase, the cooperation agreement plays a complementary role to the invention patent in the sense that it allows us to clarify the conditions and interactions between the actors of innovation by signaling the competencies of the respective partners as well as previously concerned knowledge. This reduces the uncertainties relative to the appropriation of exchanged and created knowledge, uncertainties often associated with rivalry degrees between the members of the agreement in technological matter and over the final innovation market. It then assures a knowledge securitization function by integrating competitive politics and patent legislation.

More precisely, the cooperation agreement makes the use of *background*, *sideground* and *foreground* knowledge explicit in the upstream and downstream phases of the innovation project; it equally defines the questions relative to the sharing of results of the cooperation. The formalization of such a legal document intervenes upstream in the innovation process. As explained by Attour and Ayerbe [ATT 15, p. 10], "*the question of the sharing of rights associated to the joint development of technology needs to be apprehended from the earliest phases of negotiation. It is particularly sensitive because it implies a knowledge management that must clearly account for the respective rights of the partners and the possibilities of future valorization*". From this perspective, when a collaboration concludes, many questions related to the upstream and downstream of IPR management must be discussed [PÉN 13, p. 32]:

– *How to manage previous know-how and the IPR (background)?*

– *How to fairly evaluate the contribution of each of the partners?*

– *How to equally distribute the fruits of cooperation (foreground)?*

– *How to preserve the research developed by each of the partners during the life period of the cooperation (sideground)?*

– *How to better valorize the results of cooperation that will not be used by the partners?*

The answers to these questions will enable us to identify the degree of protection and the associated appropriation regime (strong or weak) that it is convenient to adopt. According to Teece [TEE 86], the choice of a strong appropriation regime (invention patent for example) or a weak one (an *open source* regime, for instance) depends on the degree of difficulty in protecting knowledge. To determine this, it is convenient according to Woo *et al.*

[WOO 15] to distinguish the arguments in favor of a strong or weak appropriation regime according to the own characteristics of knowledge. Absorption capabilities are, for example, according to Brusoni *et al.* [BRU 05], of little necessity to imitate explicit knowledge. They can consequently be subdued by a strong intellectual property regime. On the contrary, as know-how is difficult to imitate [WIN 98], the protection of tacit knowledge may favor a weak appropriation regime.

More generally, the answers to questions associated with the upstream and downstream management of IPR show how during the upstream innovation process, the actors determine or agree on the conditions [ATT 15]:

– of sharing, of exchange and of use of previous knowledge in the phases of invention and commercialization of the invention;

– of appropriation, valorization and use of the *sideground* and *foreground* knowledge in the phases of invention and commercialization of the invention.

In the case of the Sophia Zen ecosystem, for example, the reading of the cooperation agreement shows that the management of the IPR associated with previous knowledge, for instance (Box 2.10), takes part in the generation, application and knowledge valorization process. More broadly, through this example, we understand the balance between the invention patent and the cooperation agreement, on the one hand, and their determining role in the upstream phase of innovation, on the other hand. By protecting previous knowledge and by offering a protective legal frame during the negotiations associated with the use of knowledge and also with the property of the results resulting from their combination, the invention patent and the cooperation agreement allow for the support of different knowledge management processes in different models of collective innovation (innovation networks, research consortiums, formal and informal collaboration, etc.).

From the point of view of the knowledge developed before the collaborative project (previous knowledge), the cooperation agreement of Sophia Zen states that "*each of the parties conserves the exclusive property of its previous knowledge, its IPR and its corresponding know-how).* An informative (but non exhaustive) list of previous knowledge was established for this and, as precised on the cooperation agreement, could be the object of an upgrade in function as the project unfolded. In this agreement, it was also admitted that the use of previous knowledge by one of the actors constituted in open source software or held in virtue of an Open License must beforehand be specified to the second actor. Indeed, the use of an open license implies that all or part of the results receive an open source license. Besides, the cooperation agreement foresees that the use of previous knowledge with exploitation aims must be subject to a previous agreement between the two actors. It also foresees the possibility of conceding a non-exclusive license, without sub-licensing rights, and non-yieldable for use of previous knowledge which is necessary for the exploitation of results (on condition that any of the third parties opposes itself to the concession of such a license). Taking into consideration these two restrictive clauses and the fact that the UNS had a view of placing an open license source over CHEMIN, the two components of Sophia Zen were developed in an independent manner. The previous explicit knowledge of an actor was not mobilized in the conception of the component of the other actor. Only the tacit knowledge was exchanged between the actors, especially the "know-how" type of knowledge in the frame of learning and the working practice contracts of the Master MBDS. The latter, closely related to the ideation and definition of concepts, are not, in effect, patentable.

Box 2.10. *Management of intellectual property rights within the Sophia Zen ecosystem (reading of the cooperation agreement)*

Ultimately, beyond the typology of processes and knowledge types, the second chapter offers elements for understanding the way in which the three fundamental knowledge processes implied in the development of innovation are articulated: generation, application and valorization of knowledge (see Figure 2.1). This articulation is:

– facilitated by the knowledge absorption process that intervenes equally within the generation, the application and the valorization of knowledge;

– conditioned by the way in which the management of IPR associated with previously created knowledge, during or by the innovation, is defined in the upstream process;

– the result of a transformation process, sometimes iterative, of individual and collective tacit knowledge into collective explicit knowledge. This transformation is observed particularly in all phases of the lifecycle of innovation.

3

Managing Knowledge to Innovate: Open and Distributed Innovation Models

This chapter discusses the knowledge processes supporting the interactive approaches to innovation, all of which consider that innovation results from the capability of organizations to mobilize and exploit knowledge distributed inside and outside their boundaries. Four approaches are highlighted:

1) open innovation;

2) user innovation;

3) community innovation;

4) crowdsourcing.

From the eighties onwards, many management authors recognized the importance of knowledge in the construction of competitive advantages [WER 84, BAR 91] and innovation capabilities [COH 90, KOG 92, HAM 94]. In the decade of 2000, the advent of a knowledge economy [FOR 00], as a consequence of the development of the Internet, led to a renewed interest in the way in which we relate to knowledge, particularly with innovation.

The concept of *Open Innovation*, made popular by Chesbrough in 2003, [CHE 03] constitutes a federating frame for these new approaches of innovation. Indeed, behind the banal idea according to which the innovating firm resorts to external knowledge and seeks to multiply valorization channels of the produced knowledge, a multiplicity of innovating practices

Knowledge Management and Innovation: *Interaction, Collaboration, Openness*,
First Edition. Pierre Barbaroux, Amel Attour and Eric Schenk.

lies hidden. In this way, we find the concept of "*coopetition*", which implies that in a logic of business ecosystems [MOO 93, MOO 96], innovation partnerships between firms that can find themselves in competition elsewhere. A group of innovation practices also relies on users (*User Innovation*) or on knowledge communities. Finally, *Crowdsourcing* is an innovation practice that, thanks to the Internet, enables access to competencies distributed within the crowd.

3.1. Open innovation

Conceptualized by Henry Chesbrough in 2003 [CHE 03], *Open Innovation* today provokes enthusiasm in the academic world as well as in the economic environment. Thus, in 2012, a Dutch team formed around Wim Vanhaverbeke proposed a report concerning the development of open innovation for SMEs. In 2014, with the Arthur D Little and Bluenove societies, the National Confederation of French Employers (MEDEF) published a barometer of open innovation, making an inventory of practices in the matter by the French firms.

Open innovation is today a major subject of interest for firms. In fact, it is a very generic concept, which encompasses varied modalities. For Chesbrough, open innovation is defined in opposition to the closed model, in which the innovative firm relies only on internally developed knowledge and seeks to maintain exclusive use of their research results:

> "*Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology*." [CHE 06, p. 1]

While it has worked during the 20th century, the closed innovation model today presents two pitfalls for the firm. The first one is to overlook relevant solutions developed outside the boundaries of the firm. Thus, for Gassmann [GAS 06b], the "do it yourself" mentality which long dominated in the world of R&D has today been surpassed. The second risk is not being able to distribute or to sufficiently valorize its innovations, by lack of means.

3.1.1. *The concept of open innovation*

The model of open innovation relies on a funnel vision of innovation (*innovation funnel*), which is related to the *stage-gate* model (Figure 3.1) often used for the development of new products.

Figure 3.1. *The stage-gate model of product development (www.stage-gate.com)*

The funnel image translates the idea of progressive fine-tuning of the innovation process: in the upstream phase, the process is fed by ideas and concepts of products. After selection, some of these ideas progress to a development phase, then testing, before their market launch. The challenge is then to choose the "best" concepts, that is to say, those capable of finding a potential market.

In closed innovation, this process is performed in an impermeable manner toward the exterior (Figure 3.2): the frontiers of the firm prevent knowledge leaks to the exterior. This approach is especially translated by an intensive use of industrial secret and defensive patent [LEB 10]. Besides, in this closed model, the firm relies exclusively on solutions and knowledge developed internally. The NIH or "*not invented here*" syndrome [KAT 82] represents the aversion the R&D teams may have toward knowledge developed outside the organization.

Contrary to closed innovation, open innovation is characterized by the permeable frontiers of the firm (Figure 3.3). R&D teams not only try to use knowledge developed at the exterior of the firm, but also seek to have the knowledge developed internally and valued externally.

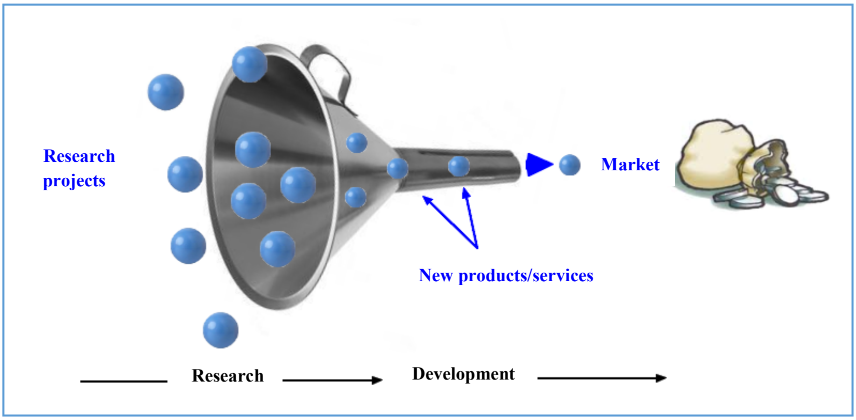

Figure 3.2. *"Closed" innovation (inspired from [CHE 03])*

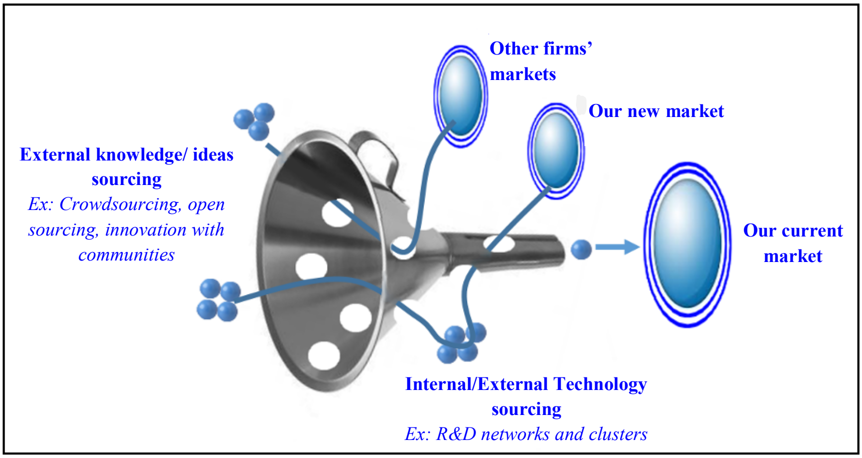

Figure 3.3. *Open innovation (adapted from [CHE 03])*

3.1.2. *The two facets of open innovation*

Open innovation as described by Chesbrough (see also [ISC 11, PÉN 13]) then comprises two relatively distinct facets. The *outside-in* dimension designates the knowledge flow from the exterior to the interior of the firm, and thus represents the use of external knowledge in the internal innovation process of the firm. This does not constitute a real novelty compared with the innovation practices developed during the 20th century. In effect, the *outside-in* dimension appears every time a firm imitates another or grounds its knowledge in external sources or know-how. For example, innovations based on imitation or even bypassing of patents constitute typical forms of the *outside-in* model.

The second dimension, called *inside-out*, stresses the knowledge flows going toward the exterior of the firm. The aim is to value the knowledge which was developed internally through external channels. In a world where competitive advantages are often associated with the exclusive exploitation of a technological patent, this approach is much less widespread than the farmer. Nevertheless, it frequently appears in the pharmaceutical and biotechnological industries [PÉN 13, PÉN 08]. In these industries, numerous firms specialize in the development of medicines. The licenses for exploitation are then yielded to big pharmaceutical firms that possess the capabilities and the means for the industrialization and commercialization phases.

While the dichotomy between the *inside-out* and *outside-in* processes is structured, these two sides are often mobilized concomitantly in collaborative innovation projects (Figure 3.4).

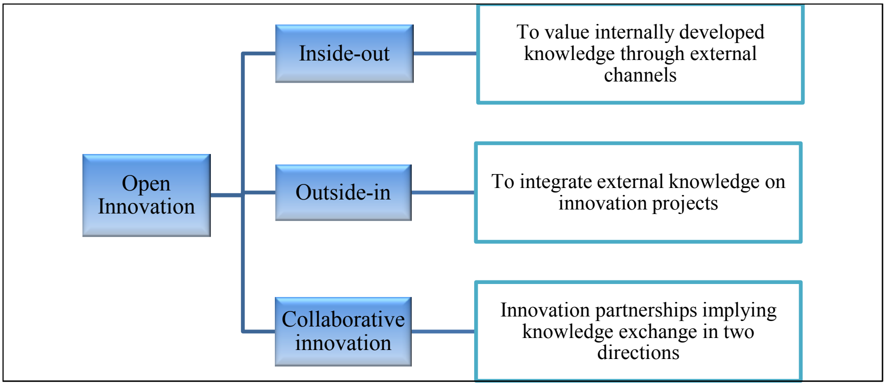

Figure 3.4. *The facets of open innovation*

3.1.3. *Open innovation modalities*

The development of the concept of open innovation can be explained through many factors [PÉN 13]. In the context of a globalized economy and increased competition, intensive innovation [LEM 06] becomes imperative for firms. This innovation becomes more and more technical and expensive and it becomes difficult or even impossible for a firm by itself to ensure the activities associated with innovation. The rise of the Internet and of information and communication technologies (ICT) enables easier connection of innovators: inventors, user communities, research laboratories, R&D centers, etc. This connection is not only spatial and temporal, but also cognitive. Indeed, the development of expert systems, collaborative working tools and digital simulation techniques are important levers of knowledge codification and of the sharing of this knowledge.

These tools thus contribute to reducing the cognitive distance [NOO 00, NOO 07] between innovators.

For Jullien and Pénin [JUL 14], the development of ICT has given rise to a specific form of open innovation, designated Open Innovation 2.0 (Table 3.1):

	Open Innovation 1.0	Open Innovation 2.0
Pure outside-in	*Licensing-in*	
Partnership (*outside-in* and *inside-out mix*)	Co-conception Co-development Research consortium *Research joint-venture* Industrial clusters	Community innovation/*open source*
Pure inside-out	*Licensing-out* *Spin-out*	Online market places/ e-Bay Ideas (ex. Yet2.com)

Table 3.1. *Open innovation modalities [JUL 14]*

3.1.4. *The importance of intellectual protection*

Against the common belief, open innovation gives an important place to intellectual protection. Open innovation is sometimes erroneously associated with the *Open Source* model (see Box 3.2). In this model, the opening without restriction of the source codes of computer software aims, by a collective effort, at the improvement and sharing of software within the developer community.

Differing from Open Source, open innovation does not imply free access to knowledge and technology. Even if it induces, by its nature, a form of knowledge sharing, open innovation is largely inscribed in a classic vision in matter of intellectual property. Thus, the exploitation of licenses generally comes with royalties, and the results of collaborative work are not often openly available to the public. The literature insists on the importance of having a well-established intellectual property strategy from the beginning of the innovation partnership. This strategy is dynamic and must, at the same time, protect and manage the results issued from a collaboration process.

In the case of collaborative innovation, one of the major challenges is the definition of the rights of the different partners, depending on several parameters [SAU 12]:

– contribution of each partner;

– protection of previous rights;

– sharing of necessary knowledge in the framework of the project;

– sharing of exploitation rights issued from collaboration.

It is important for the success of a collaborative open innovation procedure that these questions be settled very early in the partnership process.

"Open" necessarily implies the sharing of tacit knowledge. In particular, innovation partnerships give place to socialization phenomena favorable to the sharing of tacit knowledge (see Chapter 2). Nevertheless, open innovation would certainly not exist in its current form without the existence of solid systems of knowledge protection. The emergence of open innovation is particularly explained by the increasing codification of knowledge and of technologies associated with the expansion of ICT, and by the reinforcement of intellectual property rights [PÉN 13].

3.1.5. *Advantages and drawbacks of open innovation*

Table 3.2 summarizes some of the advantages and difficulties often associated with collaborative open innovation.

Advantages	Comments
Sharing of costs and risks	Collaboration implies a sharing of means and failure risks between several partners
Acceleration of the innovation process	For example, through the mobilization of competencies and the expertise of the different partners
Valorization of existing intellectual property	This valorization is done from an inside-out logic, most often through licenses concerning invention patents
Access to more resources and a larger variety of competencies	For example, the Joy Law attributed to Bill Joy, co-founder of Sun Microsystems, stipulates that "*No matter who you are, most of the smartest people work for someone else*"
Synergy with regard to technical and commercial competencies	Collaborators often possess complementary competencies, OI thus combines their technical and commercial expertise
Reinforcement of relations between existing partners	Open innovation implies an increase in communication between partners
Difficulties	**Comments**
Management of previous intellectual property	It is necessary to protect, in a preventive way, intellectual property prior to collaboration
Management of intellectual property arising from joint work	The intellectual property of products resulting from collaboration is perceived as the most critical risk in the implementation of a collaborative open innovation project
Sharing of income arising from patents	Difficulty to define the contribution of each actor of collaboration
Distribution of confidential information and commercial secrets	The opening of the innovation process to more partners increases the risks associated with the distribution of confidential information
"Free-rider" situations	Because of opportunism, certain actors can seek to profit from joint innovation without offering a significant contribution
Risk of dependence from external partners	The case often presents itself when the actors have complementary roles and their common activity cannot function beyond their partnership
Risk of internal resistance	For example, the "not invented here" syndrome translates the limitations associated with the adoption of solutions developed at the exterior of the firm
Managerial difficulty associated with the diversity of actors taking part in the open innovation process	This difficulty appears particularly when the size, the organizational structure and the financial and temporal constraints of the actors are too different (procedures, intellectual property and same specialized language)

Table 3.2. *Advantages and difficulties of open innovation*

3.1.6. *Implementation of open innovation*

The concept of open innovation is a relatively general frame of reference that in fact covers a set of relatively heterogeneous practices. In this way, the implementation of this type of procedure requires that certain questions be dealt with during the upstream phase (Table 3.3).

Why?	Why externalize a part of our innovative activities? Why share our ideas and know-how with the partners? Why would individuals, organizations and firms share their ideas and their know-how with us?
When?	When will we be able to implement open innovation? What is the ideal timing? When is it necessary to cooperate?
For which?	For which type of innovation do we want to implement open innovation? What is the expected profit?
Who?	Whom do we want as participants? Which service to imply? Who will choose the ideas? Who will develop the ideas? Whom to collaborate with?
Where?	Where will we find good participants? Where do we have to communicate?
How?	How will we know that open innovation has been a success? How to encourage our participants? How to establish mutual confidence with our participants?

Table 3.3. *The questions to be dealt with before the implementation of an open innovation project [PÉN 13]*

In the rest of this chapter, we introduce in detail some common practices of open innovation:

– user innovation;

– community innovation;

– *crowdsourcing*.

3.2. User innovation

In his book published in 1962 and re-edited in 1995, Everett Rogers [ROG 95] proposes an analysis of the distribution of innovation that distinguishes various types of users (Figure 3.5). Precocious innovators and adopters, who constitute a minority of the population of potential adopters (see bell curve in Figure 3.5), have a pioneering attitude in the matter of adoption. They are at the origin of the first phase ("emergence") in the diffusion curve (S curve).

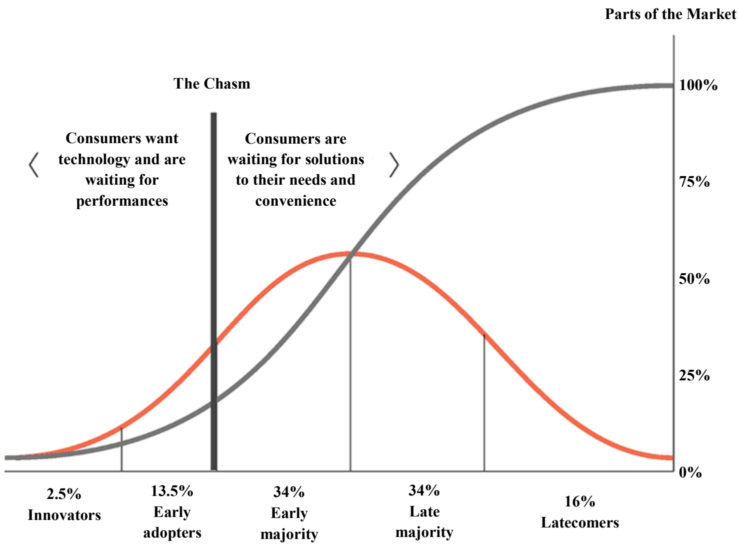

Figure 3.5. *Diffusion of innovation (adapted from [ROG 95])*

In Rogers' approach, the diffusion of innovation is not possible with the sole mobilization of early adopters and innovators. The growth of the market share demands the mobilization of a more important part of the population of potential adopters: the early majority and the late majority. While the capability to mobilize a majority of potential buyers is essential for the diffusion of innovation, it is nonetheless uncertain. Thus, the commercial failure of innovative products is particularly explained by the incapability of firms to seduce buyers beyond a hard nucleus of pioneers and early adopters.

In his book *Crossing the Chasm*, Moore [MOO 91] suggests that for radical innovations, there exists a chasm between the early adopters and the early majority. Early adopters have an attitude similar to that of innovators. They are technology enthusiasts who are inclined to adopt new technologies. On the other hand, the majority is constituted of "pragmatic" adopters. They are the first and the foremost waiting for evidence concerning the relevance of the innovation. Their adoption behavior is characterized by mimesis with regard to other pragmatic adopters. According to Moore, the chasm appears when the market composed of the population of early adopters is tight, and the pragmatic adopters wait for a movement on the part of other pragmatists. This inextricable situation is described by the term *Catch-22,* with reference to the satirical novel published by Joseph Heller in 1961.

During the nineties, economic theory shed new light on these technology adoption behaviors, especially through the notions of increasing returns to adoption and path dependence [ART 94]. This approach explains how the succession of adoption behaviors that may seem insignificant contributes to the diffusion of radical innovations.

3.2.1. *The concept of user innovation*

The place of users is not limited to the act of adoption described in the previous section. In a seminal work, Eric von Hippel [VON 88] develops the idea according to which users can be at the origin of innovations. In this User Innovation approach, some users possess competencies, needs and motivations that lead them to play an active role in the production of innovation. These users have been identified in numerous domains (Table 3.4).

Sector	Data	Reference
Software for the conception of printed circuits	User firms present at the PC-CAD conference	Urban & von Hippel [URB 88]
Pipe clamps	Employees in 74 installation firms	Herstatt & von Hippel [HER 92]
Information systems for libraries	Employees in 102 Australian libraries using the computerized management system OPAC	Morrison *et al.* [MOR 00]
Chirurgical equipment	261 surgeons working in clinics or university hospitals in Germany	Lüthje [LÜT 03]
Security functionalities of the Apache software	131 advanced users of Apache software (webmasters)	Franke & von Hippel [FRA 03b, VON 88]
Outdoor products	153 catalogue addressees for outdoor activity products	Lüthje [LÜT 04]
Extreme sports equipment	197 members issued from 4 clubs specializing in extreme sports	Franke & Shah [FRA 03a]
Mountain bike equipment	291 mountain bikers	Lüthje *et al.* [LÜT 06]

Table 3.4. *Lead users in the literature (inspired from [VON 05])*

The theory proposed by von Hippel [VON 88], later refined in his work *Democratizing Innovation* [VON 05], gives a central place to lead users. These users are ahead of the evolutionary tendency of technology, and they have needs that the majority of users will only express later on. Lead users also possess the motivation and often the competence to develop technical solutions that respond to their needs. The innovations that result from this procedure have strong chances of interesting a larger mass of users and of becoming commercially successful. Numerous examples illustrate this process, an emblematic case being that of the GoPro action camera (Box 3.1).

The GoPro action camera, particularly known through the 40,000 meter jump of Felix Baumgartner which was watched by more than 39 million people on YouTube, is the fruit of an idea and the development work of Nick Woodman. This American, born in 1975, was a passionate surfer, which led him to pursue his studies at the University of California in San Diego. In 2001, after his diploma in visual arts and a first failed entrepreneurship experience in the online gaming sector, Nick Woodman, unemployed, departed on a “surf trip” to Australia and Indonesia. He then met Brad Schmidt, the current creative director at GoPro, with whom he started to assemble his first harness permitting him to fix his camera onto himself. Back in California, 5 months later, Nick Woodman made the firm decision to lead his project to success. Aged 27 years, Woodman broke with the “normal” life he previously led. He isolated himself in a house not far from Silicon Valley to undertake the development of the first GoPro prototype. The working days of Woodman were intensive, turning sometimes to obsession. In 2004, Woodman was in measure of proposing the sale of the first GoPro camera, based on a 35-mm camera whose cost barely exceeded 3 dollars. The GoPro camera was born, resulting from the passion and the will to succeed of an innovative user. Today, GoPro is the leader in the market of action cameras, which comprises global companies such as Garmin, Sony, Shimano and Polaroid. This market is in full expansion. According to a study conducted by Future Source[1], the global market of action cameras benefited from a growth of 44% in 2014, with 7.6 million units sold and a business turnover of 3.2 billion dollars. According to the study, the market share of action cameras represents 12% of the market of image capture devices and should increase to 37% by 2019, then surpassing compact cameras. The dynamism of the action camera market is explained by the development of social networks as well as by the innovations that characterize these products, particularly in image quality (high-definition development, etc.). But, above all, these products respond to new needs which develop in an ecosystem context. For example, the expansion of drones constitutes a formidable opportunity for the manufacturers of action cameras.

Box 3.1. *The GoPro example*

1 http://www.futuresource-consulting.com/2015-07-Action-Cameras-Market-Growth-1235.html.

3.2.2. *Lead users activities*

The 20th century economy is characterized by the development of mass production as the dominant industrial model. Recent years have seen an increasing demand for differentiated and personalized products [PIL 10]. In a context where users' needs are very heterogeneous, the "a few sizes fit all" strategy [VON 05] leaves numerous consumers or users unsatisfied by the "classic" industrial offer. The users who face problems which the majority of consumers do not have are left with no other option than to develop their own modifications to existing products, or to invent entirely new products. In other words, the users who wish for a specific product will obtain a satisfying result by innovating themselves. In fact, industrial firms are not generally designed to respond to very specific demands (Figure 3.6).

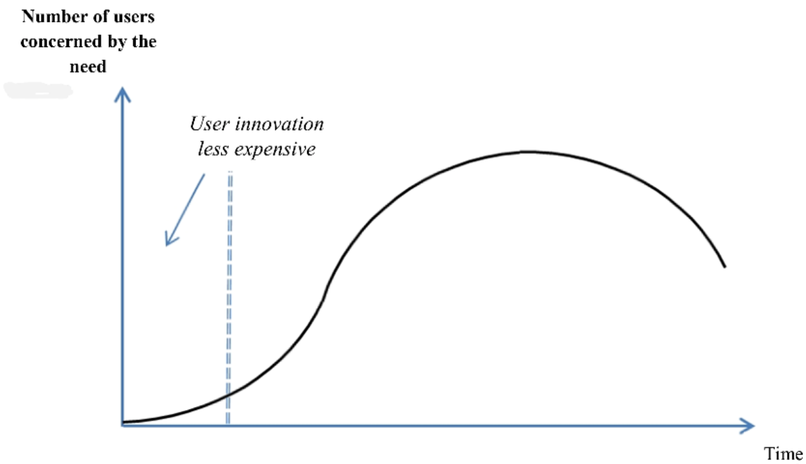

Figure 3.6. *Innovation by users and by firms [VON 88]*

Lead users can intervene in many different ways in the innovation process. In some cases, their role is limited to proposing ideas for product improvement [CHR 97, VON 88]. In a more radical way, the lead users can be in charge of the integrality of the innovation process in order to respond to a need which differs hugely from the existing offer. The development of the GoPro camera (Box 3.1) responds to this logic. In this context, the role of firms consists of continuing the work of the lead users during the industrialization phases when the demand for new products is sufficiently significant. Finally, the involvement of users in the innovation processes can be done through the processes of co-creation and co-development, even by the taking up of supporting activities [NAM 02]. For example, the sports equipment company Salomon (who produce skis, ski bindings, trail running equipment, including shoes, etc.) has benefited from the competence of the professional athlete Kilian Jornet for the development of the S-Lab Sense trail running shoe and the S-Lab equipment line. In this case, the users cannot only be considered as knowledge sources, and open innovation does not only imply an outside-in process type [POE 12]. In a co-creation or co-development procedure, the users actually become avenues of access to the markets ("external paths to market", [BAL 06]). For Rayna *et al.* [RAY 15], co-creation with users is possible at many stages of the innovation process: co-design during the conception phase, co-production during the manufacturing phase, and distribution. Co-creation can also be done with individuals or communities [SAW 00, PIL 05].

Co-creation can be associated with the notion of mass customization, which reflects the production of personalized or customized goods at a large scale; however, these are quite distinct concepts. In fact, mass customization does not forcibly imply co-creation with users or open innovation [CHE 12]. For example, when mass customization is translated into the existence of choices among a predefined set of possibilities (color, size, etc.), we cannot define this as co-creation nor even as innovation because customization is not translated into the emergence of a novelty [PIL 10]. Thus, user innovation corresponds to a particular site at the intersection of co-creation, mass customization and open innovation (Figure 3.7).

3.2.3. *Competencies of user-innovators*

The user innovation paradigm relies on the hypothesis according to which certain users possess a particular competence allowing them to innovate. Thanks to their advanced use of technologies, lead users possess specific consumer knowledge. This knowledge possessed by the user enables him to face problems in use situations, for example, to choose the right product and function for the use situation [BRU 85, MIT 96]. Expert users, who possess deep consumer knowledge, will be more prone to endorsing the status of lead user. In fact, proper knowledge of a product's characteristics and its use is often considered the prerequisite for creativity and innovation [SCH 08].

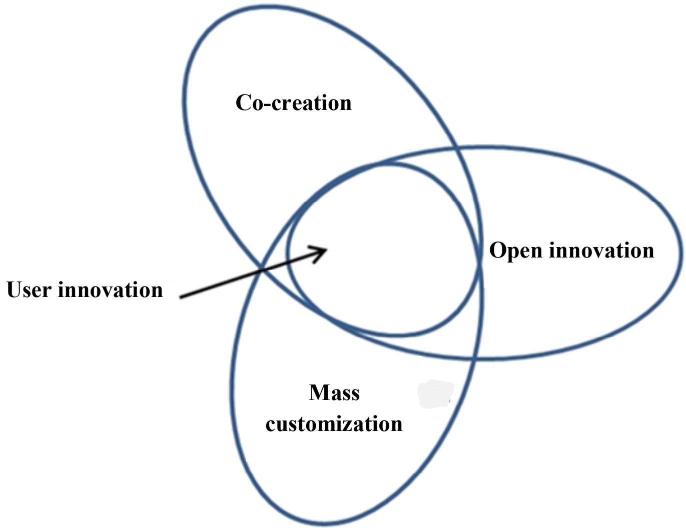

Figure 3.7. *User innovation at the intersection of three models [RAY 15]*

With experience, the expert users develop patterns and metacognition that enable them to acquire new knowledge faster and to possess a deeper and more comprehensive vision of the encountered problems. This expertise is the fruit of prolonged experience as well as of deliberate practice [ERI 06, ERI 07]. In fact, while it is necessary, experience alone is not sufficient to become an expert. Research on the psychology of expertise in the domains of sport, music or chess underline the importance of the individual's engagement in a learning process through the notion of deliberate practice, which describes a permanent attitude of experimentation with the aim of learning.

Expert competence is one of the elements that determine the capability of lead users to identify new uses and technical solutions, allowing them to provide an answer to the problems encountered in practice. According to Amabile [AMA 88], individual creativity is the combination of three factors: expertise, creative thinking skills and motivation (Figure 3.8).

Figure 3.8. *The three components of individual creativity [AMA 88]*

The literature underlines the capability of lead users to anticipate market tendencies and to make decisions "ahead of time" by comparison with the classic R&D actors [LIL 02, MOR 04]. Thus, lead users are often at the origin of new industries. Note that the expert competencies held by users are strongly tacit. They are the fruit of experience which has been interpreted, analyzed and ranked by users throughout time and are at the origin of a fine perception of the problems encountered in the situation and the capability of providing answers. This tacit knowledge ([HIP 88] uses the term "sticky knowledge") is contextualized and associated with individuals.

3.2.4. *Implementation of user innovation*

Apart from their competence, lead users benefit from important flexibility in the matter of innovation. In their activity, these actors are not constrained by the traditional stages of the stage-gate model or by the standardized procedures of project management that predominate in firms.

Besides, lead users do not cover fixed costs of infrastructures. The perspective of witnessing the emergence of a solution to their problems constitutes a motivation for the necessary (time) investment. Thus, in a similar way to entrepreneurs, these actors possess an internal locus of control. While the main motivation of lead users is not commercial, the capability of users to anticipate market trends is of prime interest for the firms essentially motivated by future profit. The literature tends to show that the innovation produced by lead users carries a strong level of sophistication and that they provide high value to customers.

We note that the mobilization of lead users is very different from approaches based on listening to customers [DAN 04]. Certain authors (see, for example, [CHR 97]) have shown that excessive listening to users could lead firms into an "incremental trap" susceptible to dramatic consequences for their survival in a context of radical evolution of technologies. Lead users are not representative of the majority of users but their practice situates them in advance of the existing market. Thus, by mobilizing lead users, the firms do not risk falling into the innovator's dilemma as described by Christensen [CHR 97].

Consequently, how is it possible to marry the "classic" model of new product development with the activity of lead users? For von Hippel, the lead user method can be decomposed into four stages (Figure 3.9).

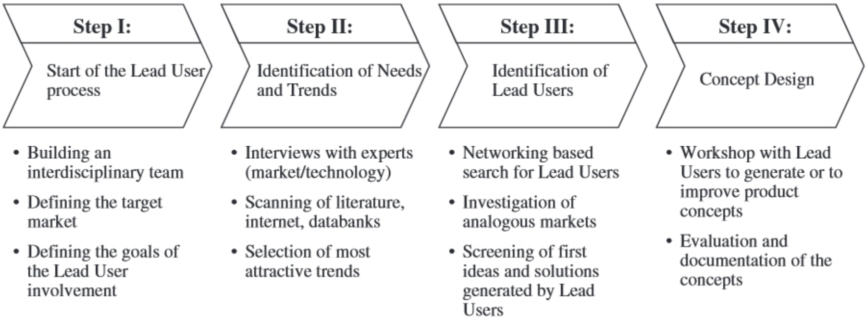

Figure 3.9. *The stages of a lead user method [VON 88]*

3.2.4.1. *Identification of lead users*

The implementation of user innovation requires the identification of lead users. Following von Hippel [VON 88], lead users are defined by six characteristics:

– located at the bleeding edge of trends;

– strong motivation to innovate;

– excellent knowledge of the domain of innovation;

– excellent knowledge concerning the uses in the domain;

– strong capability to innovate (innovativeness);

– internal locus of control.

The literature highlights three approaches to identify lead users [PIL 06, VON 05]: detection (screening), pyramidal research (pyramiding) and self-selection. Detection or screening consists of identifying lead users on specialized sites or in shared interest communities by looking for specific characteristics. Pyramidal research consists of identifying people in the explored domain (for example, experts) in order to access other experts who have more knowledge, and thus climb up to lead users. This sequential method relies on the principle of the experts in the same domain having the tendency to know each other. Detection is a parallel research method limited to previously well-identified characteristics. The pyramidal method is a sequential research method revealing criteria for expertise which, a priori, had not been identified. Von Hippel *et al*. [VON 08] show that this method requires a less important population base than the detection approach, what makes it more efficient. Finally, self-selection consists of providing users with devices that will allow lead users to identify themselves in connection to the firms. User toolkits correspond to this category.

3.2.4.2. *User toolkits*

The aim of user toolkits is to facilitate relations between the firm and its innovative users, by way of personalization, conception and prototyping interfaces. The principle is that the users employ the user toolkit with a precise knowledge of their needs in order to carry out one or more stages of the innovation process (production of the preliminary concept, prototyping or simulation, evaluation of its functioning and improvement). For example, these tools are largely developed in the sector of semiconductors, where they enable a significant reduction of the conception time [THO 02]. In the video-game sector, toolkits enable users to produce personalized modules and extensions [JEP 05, PAR 13].

User toolkits enable to dissemble two types of activities of the innovation process: the tasks associated with needs (identification of needs and search for solutions) are assigned to the users, whereas the tasks connected with the implementation of solutions are assigned to the firms [VON 01]. This approach deals with the management of necessary knowledge to innovate. This kind of knowledge, strongly tied to user experience, is tacit and not easily transferable (sticky knowledge). User toolkits enable mobilization of the innovation competence of users without going through the stage of codification of their knowledge.

According to von Hippel [VON 01], user toolkits must possess the following characteristics (see also [VON 02a]):

– direct learning by trial and error. The toolkit must enable the user to directly conceive, test and evaluate the results of conceptions without comings and goings between the manufacturer and the user. This enables the user to enter into an iterative learning cycle until reaching a satisfying solution for his needs;

– an appropriate solution space. The toolkit must propose a predetermined solution set, sufficiently large for the user to be able to find a solution adapted to his needs. This sometimes requires the re-conception of products toward greater modularity;

– the availability of model libraries. The toolkit must give access to a base of ready-to-use models. The conception operated by the addition or withdrawal of elements over already conceived models results in a time gain;

– ease of use. The toolkit must be able to be taken in hand in an intuitive and quick manner and the language used must be the closest possible to that of the user;

– direct transfer. The toolkit must integrate all the production constraints and propose no more than what is possible to directly transfer during production. This transfer without translation or adaptation of the user conception toward the production tool is the source of efficiency (there is no re-conception before manufacturing) and allows limiting the risk of mistakes in the translation phase.

Despite the existence of toolkits, the importance of tacit knowledge in the process implemented by the lead users is a limiting factor to the transfer of their innovation capabilities toward the firms [VON 98]. In this way, for users, it will be far easier to interact in an informal way and to share knowledge within a community of users.

3.3. Innovating with communities

From the works of Lave and Wenger and of Brown and Duguid at the beginning of the nineties, numerous authors in the field of management have intended to apprehend and deepen the concept of community of practice (see, for example, [AMI 04, COH 04, COH 06, COH 10a, COH 10b, COH 10c]). In order to account for different forms of communities within one federating concept, Amin and Cohendet [AMI 04] use the term "knowing communities" (the term "knowledge communities" is also used in the literature). These communities are structured around the notion of practice. In fact, in line with Schön [SCH 95], it is generally considered that "knowing" refers to an epistemology of practice.

Knowledge communities can sometimes be assimilated to communities of practice in which the members, who share a common language, exchange knowledge around their practices in order to improve their individual competencies. These communities also have an epistemic dimension since they explicitely aim at producing knowledge and innovation and knowledge production [COH 10a, COH 10b, COH 10c, FRA 03a]. Thus, knowledge communities are at the same time centered in exploitation activities and in exploration activities, which produces social structures favorable to organizational ambidexterity [DUP 11].

Communities possess four distinct elements [MCD 10]. Their main aim is the production of knowledge, their functioning relies on a system of shared norms, they do not have any predetermined life duration, and their frontiers are not clearly defined. Thus, communities liberate themselves from the frontiers of formal organization [BRO 01] and, in particular, they distinguish themselves from project teams. Knowledge communities seek permanence, which produces memory places for the organization that takes them in [AMI 04]. Communities are not governed by contracts or other financial incentives, but by the trust and the reputation relationships associated with the respect of the community's social norms [LER 02, VON 12].

Open source software (Box 3.2) illustrates the importance of knowledge communities in collective innovation processes.

Open source software (OSS) represents a category of software whose source code, accessible to everyone, can be freely modified. The notion of open source software finds its origin in the free software foundation initiated by Richard Stallman in 1984 around the GNU project. Stallman considered that IT software must be accessible to all, without restrictions. The GNU project gave place to the GPL license (general public license) qualified as copy left, and which still constitutes a reference in the matter of open source software. This license gave the right to copy and modify source codes. The vision advocated by Stallman is essentially libertarian and the notion of "free software" refers to the liberty to access the source codes, not to the financial character of the software.

In his work *The Cathedral and the Bazaar* published in 1999 [RAY 99], Eric Raymond defends the idea according to which accessibility without restrictions to the source codes of software contributes to the improvement of the programs by a collective effort within the user and developer community. In spite of being inspired by Stallman, Raymond's approach is more pragmatic. He considers that the opening of the source codes (hence the term open source) induces an improvement of the quality of software, especially by the elimination of bugs ("given enough eyeballs, all bugs are shallow"). The most famous open source softwares are Linux, Firefox, Apache/Open Office and Android. Many open source projects are accessible via the Sourceforge Internet platform (http://sourceforge.net).

Numerous works have used OSS as support to understand the collective knowledge production model. For example, von Hippel and von Krogh [VON 03] show that OSS developers are mainly motivated by belonging to a community and by the shared quality of their collective production. The authors refer to a "private-collective" model, which features a knowledge sharing mechanism based on reciprocity within the community of contributors. By extending the analysis of the motivations of contributors proposed by Lerner and Tirole [LER 02] and von Krogh *et al*. [VON 12], they show that in order to stimulate innovation in free software, it is convenient to combine extrinsic motivations with more intrinsic and non-monetary motivations associated with community membership.

Box 3.2. *Open source software*

3.3.1. *Social interactions and knowledge production within communities*

The notion of a community of practice (CoP) has been popularized by Lave and Wenger [LAV 91] and Brown and Duguit [BRO 91]. It makes reference to informal groups of individuals, structured around internal rules and who are committed to producing knowledge around specific domains. CoPs are spontaneous social organizations who are built independently from the organizational structure that houses them. At first, they appear invisible to the organization. Knowledge communities possess the following characteristics [AMI 08, BRO 91]:

– community members accept to participate in a voluntary and regular exchange concerning a common interest subject or a specialized knowledge domain;

– through their repeated interactions and a common practice, a shared identity and social norms are progressively built, which constitute (tacit or codified) rules of coordination between individuals;

– they do not possess hermetic boundaries. In this way, the entry of new members to the community is always possible;

– they are not managed by a visible hierarchy. Besides, there is no explicit control through rules and procedures;

– individual engagement is not regulated by contractual forms, and classical modes of incitation and control are not applied.

For Amin and Cohendet [AMI 04], knowledge communities are defined by a voluntary engagement in the construction and sharing of a common knowledge directory, by the construction of a common identity through repeated exchanges, and by the respect of the community's social norms. They are socialization places in which codification efforts and knowledge sharing are performed, guided by adhesion to the social norms that found the community [VON 12]. Being knowledge-based communities, they are structured around the notion of practice. These practices produce tacit knowledge or knowing-in-action [SCH 95].

Concerning the production of knowledge, the literature makes a distinction between the communities oriented toward the exploration of new knowledge and the communities oriented toward the accumulation of knowledge over an already well-mastered domain [PRO 07, BOR 08, MCD 10].

The differences in the nature of knowledge explain the heterogeneity of knowledge communities, in terms of social ties and in relation to innovation and organization (Table 3.5).

Activity	Type of knowledge	Nature of communication	Innovation	Organizational dynamic
Craft/task-based	Tactile learning (kinesthetic and embodied knowledge)	Face to face communication	Customized, incremental	Hierarchically managed, open to new members
Professional	Specialized expert knowledge, declarative, embodied knowledge	Co-location required in the development of professional status	Incremental or radical but strongly bound by professional rules. Radical innovation stimulated by contact with other communities	Large hierarchically managed organizations. Institutional restriction on the entry of new members
Epistemic/creative	Specialized and expert knowledge. Intends to extend knowledge base	Spatial or relational proximity, combination of face-to-face and distanciated contact	Radical Innovation	Project managed Open to those with a reputation in the field. Management through intermediaries and boundary objects.
Virtual	Importance of knowledge codification. Exploratory and exploitative	Social interaction mediated through technology	Incremental and radical	Carefully managed by community moderators. Open, but self-regulating

Table 3.5. *Knowledge community types (inspired from [AMI 08])*

3.3.2. *Communities in the firm: between governance and spontaneity*

Firms are becoming more and more conscious of the importance of knowledge communities as a vector of innovation and of operational performance. In a pioneering work, Gongla and Rizutto [GON 01] have sought to understand the life cycle of practice communities at IBM (Table 3.6).

Phase	Potential	Construction	Engagement	Active	Adaptative
Function	Connection between individuals	Memory construction	Learning	Collaboration	Innovation
Individual behavior	Contact	Experience sharing. Construction of rules and of a common vocabulary. Elaboration of a shared directory	Engagement, confidence, loyalty. Research of new members and knowledge enabling to feed the community	Asks members to perform tasks, creation of specialized groups. Interaction with other communities	Environment modification by the creation of new products and new activities. The community sustains other communities
Relationship with the organization	The community is not yet visible	Recognition of the community by the organization	The organization interacts with the community and is conscious of its potential	The organization actively sustains the community and entrusts it with certain activities	The organization uses the community for the development of new activities
Support process	Identifying and finding potential members, ease of contact	Availability of knowledge management tools	Help to the socialization of new members, management of knowledge fluxes, continued improvement and problem-solving, to ensure autonomy	Problem-solving and decision-making assistance, integration of organizational processes, relations with other communities	Flexibility and stability in time, mentoring of new communities, focus on innovation
Technologies support	E-mail, forums intranet, intranet directories	Shared directories, collaborative working environment	Community portals, expert directories, surveys and feedback tools	Tools for analysis and decision-making, team working spaces and collaborative working tools	Pilot use of new technologies, integration of tools coming from the exterior, technology transfer

Table 3.6. *The different stages in the life of a community (inspired from [GON 01])*

The analysis of internal communities at IBM has paved the way for literature seeking to understand the articulation between the communities and the organization, especially through the notion of CoPs management. This notion translates the idea according to which the organization looks for alignment between the activity of a community and its strategic orientations, while preserving the self-organized and spontaneous character of the community. In order to achieve these a priori contradictory aims, two mechanisms are put forward: the fixation of objectives and governance based on the roles of a coordinator and a sponsor [PRO 07, BOR 08, MCD 10]. According to McDermott and Archibald [MCD 10], the most efficient communities are those whose preoccupations have an interest for the firm. The implementation of performance indicators and of objectives enables this alignment [PRO 08]. On the other hand, the existence of the sponsor and the coordinator enables relations between the community and the formal structure of the organization:

– the sponsor grants that the community possesses the necessary resources and time for functioning correctly and, as a counterpart, it makes sure that community topics converge with the preoccupations of the organization;

– the coordinator plays the role of a facilitator within the community. He watches for the correct circulation of knowledge, the repartition of activities and the respect of deadlines within the community.

3.3.3. *Innovating with external communities: the role of the middleground*

The role of communities in the development of open source software (Box 3.2) highlights the innovative potential that lies in these informal organizations. Following Florida's approach of creative cities [FLO 02], recent work has focused on the place of communities in creative processes [BUR 11a, COH 08, COH 10a, COH 10b, COH 10c, HAR 13]. These authors develop the idea that the communities create an interface between the local actors, the members of networks or collectives and the organizations who seek to pilot innovation projects. Knowledge communities here have a catalyzing role. Thanks to their way of producing knowledge, they create a relation between the relatively disorganized world of ideation and creativity, and the structured world of the organization in project mode. The authors equally use the terms underground, middleground and upperground to characterize these sets (Figure 3.10):

– the underground corresponds to the hidden part of creative territories, that is to say, individuals and collectives who carry creative activities (scientific, technological, artistic and cultural) at the exterior of any institution or organization. It is about exploratory or cutting-edge activities, often exercised in a non-profit way;

– the middleground comprises communities who have the mission of consolidating and distributing knowledge. In this way, they constitute an interface with the underground, characterized by an informal functioning mode, and the formal organizations of the upperground. Middleground plays a crucial role in the innovation process because it makes knowledge produced in the underground accessible to the upperground;

– the upperground is composed of firms and creative institutions (artistic centers, cultural centers, etc.), which possess creativity integration and financing capabilities. These organizations put forward the notion of a project and are constrained by economic considerations. Their role consists of promoting the formalized knowledge produced in an informal way by the underground. By doing this, they generate positive knowledge externalities [ARR 62].

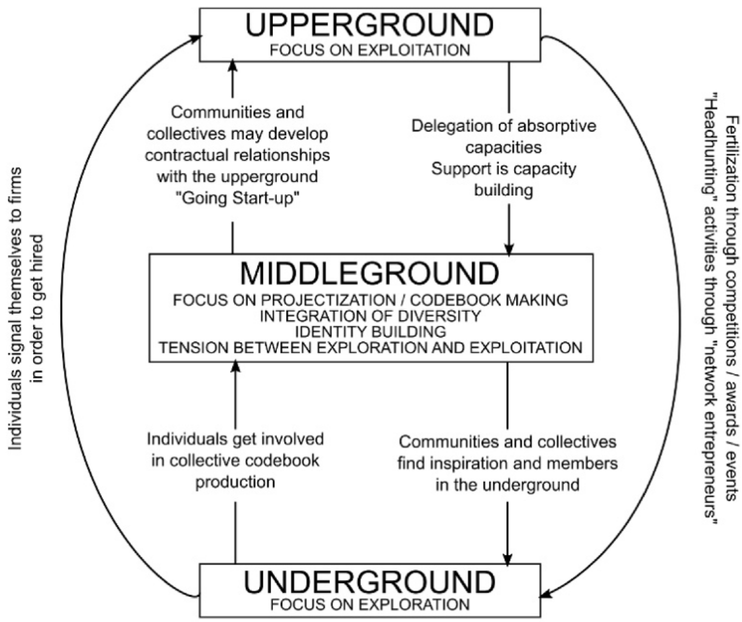

Figure 3.10. *The grounds of a creative territory [COH 10a, COH 10b, COH 10c]*

3.4. Crowdsourcing

The concept of crowdsourcing was formalized by Jeff Howe in 2006 in Wired magazine [HOW 06]. It is a contraction of the terms *crowd* and *outsourcing* and it represents the act of externalizing, via a website, an activity to a large number of individuals whose identity is a priori anonymous. This is inscribed as a direct extension of Web 2.0 and is frequently considered as a manifestation of open innovation in its outside-in dimension [PÉN 13]. Howe [HOW 08] identified four major categories on how to appeal to the crowds:

– crowd wisdom is generally associated with the field of R&D. It aims at problem solving;

– crowd voting relies on Internet users' opinions, either in the form of deliberate votes or their non-conscious contribution (for example, the page rank algorithm used by the Google web search engine);

– crowd funding, which designates participative financing;

– finally, crowd creation, which requests the creativity of the crowd, particularly in the marketing field (trademark creation, logos, slogans, designs, etc.).

The literature concerning crowdsourcing (CS) in the domain of innovation management focuses on the crowd wisdom and crowd creation dimensions. In particular, existing typologies [EST 12, PÉN 11, REN 14, SCH 12] make it possible to understand how crowdsourcing feeds the innovation process with knowledge contributions. Indeed, CS concerns different types of tasks (simple, creative or complex tasks) and the nature of the process is equally variable (integrative process vs. selective process; collaborative process vs. competitive process)

3.4.1. *A typology of crowdsourcing*

The first approach consists of differentiating the types of CS according to the nature of the tasks to be performed. Thus, it is possible to distinguish CS related to simple tasks, creative productions and problem solving [SCH 11, SCH 12].

3.4.1.1. *Simple task CS*

Simple task CS consists of mobilizing a large number of contributors for low-intensive knowledge information elements, whose production does not take long. The contributions do not possess a significant value per se and the associated remuneration to this CS is feeble, even non-existant. The CS of simple tasks is about handling big volumes of information and its value for the firm relies on its capacity to integrate a multitude of information in order to propose an added-value service. This type of CS is at the core of well-known applications such as Mechanical Turk, reCAPTCHA and Waze. With Mechanical Turk, Amazon mobilizes contributors from around the world for the realization of “micro-tasks”, such as simple translations. With reCAPTCHA (see, for example, [SCH 12]), Google mobilizes Internet users for character recognition activities. Finally, with the Waze application, users feed a system enabling the prediction of traffic jams (see, for instance, [TUC 15]). Mechanical Turk implements a principle of micro-payments, whereas for reCAPTCHA and Waze, users are not remunerated for their contributions.

3.4.1.2. *Creative production CS*

Internet contributors can also be called upon for their individual creativity, that is to say, for their capability to produce new ideas, which have potential value for the firm [AMA 88]. While these creative tasks, for example, the creation of a logo or a name, sometimes appeal to particular professional competencies, they are equally accessible (with very variable results!) to non-professionals, for example, to customers or users of the brand.

This form of CS enables the firm to have access to professional competencies at a lower cost [POE 12], but equally to approach their customers. In this way, CS is inscribed in the marketing approach of the firm [KOZ 08, WHI 09]. This is particularly implemented by the firm Lego (Box 3.3), or by the creation platforms Creads and eYeka.

In any case, it is a question of soliciting the crowd in the context of creativity contests and choosing the best production. The selected productions sometimes constitute content within a more global offer. Burger-Helmchen and Pénin [BUR 11b] thus use the term “content CS”.

Lego (*The Lego Group*) is a Danish group whose main product is the eponymous game LEGO. This game permits the creation of all kinds of three-dimensional objects from plastic bricks. The bricks, to which are added artifacts and figurines, are combined and sold in "Lego boxes" in order to reproduce particular universes.

For a long time, the Lego firm functioned with a closed innovation model, preferring to rely on internal development for the creation of new boxes. Facing a severe crisis at the beginning of the 2000s, Lego decided to modify its innovation approach with the development of the Lego Cuusoo project. This project, resulting from the partnership with the Cuusoo company, was tested on the Japanese market from 2008 to 2011. After the success of this first experimentation, the world launch of the platform was done in 2011. On April 30 2015, the Lego Cuusoo website was renamed Lego Ideas.

Its functioning principle is the following: any person enrolled on the site has the possibility of proposing a new box concept. The members of the community are called upon to vote for the projects. When a project has attained ten thousand votes, an internal team at Lego decides on the development of the product and its eventual market launch. In the case of a commercialized project, its creator perceives a remuneration totalling 1% of the generated returns.

By the end of 2015, more than five thousand models have been proposed on the platform since its creation, and fourteen ideas resulting from this crowdsourcing contest have been accepted (twelve are already commercialized and two of them will soon be). With this approach, Lego has been able to make its innovation process more dynamic by relying on an important fan community. Here, CS concerns the upstream phase of the innovation process, associated with ideation. The following phases are managed in a more traditional way.

Box 3.3. *The case of Lego*[2]

3.4.1.3. *Problem-solving CS*

In this type of CS, the firm appeals to the crowd to solve scientific or technical problems that appear during the innovation process [BRA 08, JEP 10]. Problem solving has a strong cognitive dimension and crowdsourcing then aims to access distributed expert competencies. The required experts are outside the firm's boundaries [PÉN 12], even outside its

2 See, for example, Schlagwein and Bjorn-Andersen [SCH 14], Schenk *et al*. [SCH 15].

domain of activity [BOU 11, BOU 13]. CS here serves the purpose of exploring new knowledge and Afuah and Tucci [AFU 12] refer to distant search.

Since 2001, the InnoCentive platform (Box 3.4) has become essential for the implementation of this type of CS. This platform connects organizations that face a problem and contributors distributed around the world.

InnoCentive is a spin-off from the Eli Lilly company, founded in 2001. The principle of this Internet platform is simple: the purpose is to connect organizations (firms, NGOs, etc.) called *seekers* who face an identified need, and contributors, called *solvers*, enrolled on the platform. The rewards offered by the seekers often reach thousands of US dollars. Beyond the connection between seekers and solvers, InnoCentive brings support to seekers throughout the process, for example, by assistance during the challenge formalization phase. Finally, and above all, as an intermediary, InnoCentive ensures the management of intellectual property and confidentiality. The returns of the platform derive from commissions over the rewards and the invoicing of deposits for each challenge.

The InnoCentive platform has become a true success. Since its creation until the end of 2015, more than 2,000 challenges have been proposed to more than 365,000 solvers coming from around 200 countries. 1,500 projects have been awarded over 40 million dollars, with a challenge solution rate from 30% to over 85% according to the characteristics of the challenge.

Box 3.4. *TheInnoCentive[3] case*

3.4.2. *The relevance of crowdsourcing for innovation*

CS serves the purpose of innovation in many ways. With creative crowdsourcing, firms benefit from the ideation capability of Internet users. This presents interest during the upstream phase of the innovation process, called the fuzzy front end (see, for example, [GAS 13]), where the firm does not still know what it is looking for. This type of CS is equally a co-creation tool together with users [PILL 06]. The challenges are the capability to mobilize the crowd to take part in the process, and the selection of the

3 See Lakhani [LAK 08] and Liotard [LIO 12].

winning contributions. These processes are potentially time consuming (see, for example, [SCH 16]).

With problem-solving-oriented crowdsourcing, the firms benefit from competences which are distributed and, a priori, non-accessible. This CS raises questions related to intellectual property and to the knowledge absorptive capacities, but above all, it relies on the capability of the seeker to formulate the encountered problem in a sufficiently precise manner. In a reference work, Afuah and Tucci [AFU 12] identify the factors that condition the performance of crowdsourcing for the distant research of solutions to innovation problems (Table 3.7).

Conditions surrounding…	Impact on *crowdsourcing*
the problem	
Simple or decomposable in simple sub-problems (modules)	Facilitates labor division and individual contributions
Easy to specify and to distribute to the crowd	Minimizes transactional costs
the solution	
Easy to transfer, protect and evaluate	Minimizes transactional costs and facilitates intellectual protection
the knowledge required to solve the problem	
Distributed	Makes knowledge management complex for a central authority
Hidden	
Tacit	Makes the acquisition of this knowledge difficult, long and expensive
Distant	
the seeker	
Absorptive capacity	Facilitates the exploitation of solutions contributed by the crowd
the crowd	
Large and heterogeneous	Maximizes the probability of finding a solution
Motivation	Facilitates the production of original solutions

Table 3.7. *Influencing factors of CS (adapted from [AFU 12], [SCH 15])*

3.4.3. *Crowdsourcing platforms*

In some cases, the firms choose to control their crowdsourcing platform themselves. That is, for example, the case of Lego (Lego Ideas) and Procter & Gamble (Connect & Develop). Other firms choose to resort to an intermediary platform open to other firms, as for example, Atizo, InnoCentive oreYeka.

The choice of resorting to one's own external or open platform is not insignificant. The development of one's own platform is a considerable investment that allows for exclusive control of the platform and the establishment of a privileged relation with the crowd (Figure 3.11).

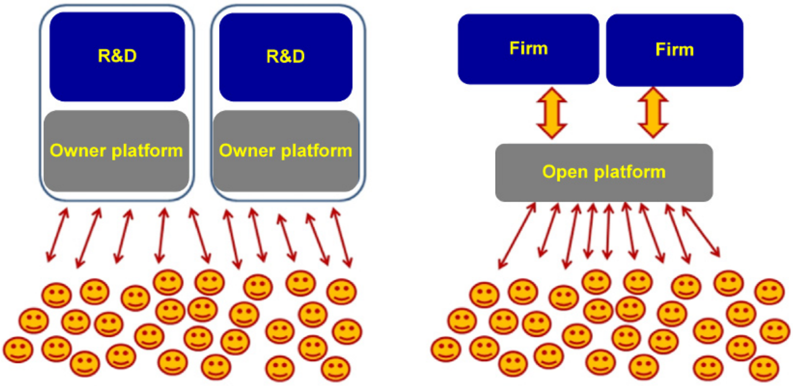

Figure 3.11. *Proprietary platform versus open platform [SCH 15]*

The decision to resort to an external platform can be analyzed by means of three theories, which are well-known in industrial economy and management [SCH 15]:

– transactional costs theory: resorting to an external and open platform enables the reduction of transactional costs inherent to the practice of CS. Indeed, the presence of an intermediary features the limitation of opportunistic behaviors;

– network effects (or network externalities): the recourse to an external and open platform offers a broader readability and enables access to a larger number of solvers, particularly in the case where the notoriety of the firm, which makes appeal to CS, is weak. Nevertheless, the resort to a proprietary platform allows for the establishment of closer relations with the crowd;

– resource-based view: by appealing to an external and open platform, the firm benefits from the resource portfolio and the competencies of the platform in terms of management of the crowdsourcing process (problem formalization, drafting of contractual clauses, etc.). On the other hand, the resort to a proprietary platform is better indicated if the firm seeks to transform the crowd into a community (see section 3) in order to benefit from a durable competitive advantage.

This analysis explains why the firms which possess internal competencies and the ability to attract a large number of contributors are more likely to build a community relationship with the crowd, using a proprietary platform. The case of Lego (Box 3.3) corresponds to this situation. On the other hand, resorting to an external and open platform (as in the case of InnoCentive, Box 3.4) facilitates access to the crowds and makes it possible to benefit from platform competencies especially designed for a crowdsourcing process. In other terms, choosing to work with a proprietary platform may become risky if the capacity to attract crowds is uncertain or if the firm lacks sufficient internal resources [SCH 15].

3.4.4. *Crowdsourcing and other open innovation models*

There exist evident similarities between CS and other open innovation models introduced on this chapter:

– user innovation and community innovation are types of open innovation (of the outside-in type), but open innovation can equally be implemented by co-development partnerships and by inside-out approaches. Moreover, when applied to innovation, CS is an open innovation modality. However, certain CS forms do not concern the innovation process technically speaking (for example, CS applied to simple task);

– CS is a modality to implement user innovation, but other approaches are also possible (identification of lead users, user toolkits, etc.). In the same way, community innovation can be performed by CS [DUP 15], but other approaches are also possible, especially through the middleground. Besides, with CS, the firm seeks the competencies distributed well beyond its user network;

– user innovation and community innovation possess an intersection in the case of user communities.

The positioning of these different approaches is represented by Figure 3.12.

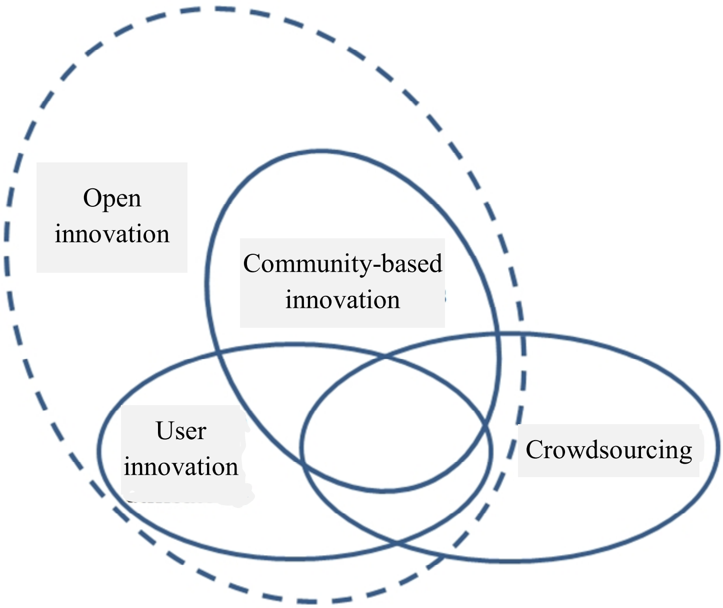

Figure 3.12. *Positioning of the different types of open innovation*

General Conclusion

The Four Challenges of Knowledge Management at the Service of Innovation

The change of paradigm [CHE 03] that represents the generalization of interactive, collaborative and open approaches to innovation justifies a supplementary research effort that finds its source in the reconciliation of literature on innovation and knowledge management. By establishing connections between different stakeholders and different knowledge sources, these approaches transform the way in which firms perceive and exploit users' potential needs and latent preferences, the technical constraints associated with the uses of developed products or even the complementarities between products of different conceptions. We have suggested in this book that these approaches induce the deployment of knowledge management processes (generation, application and valorization; Figure 2.1) adapted to the stakes of interaction, collaboration and opening. From this perspective, the challenges confronting firms are multiple. These challenges are directly associated with the management of multiple sources of innovation on which rely the generation, application and valorization of knowledge. We retain four of these:

– monitoring of the internal and external environment;

– selection of partners and knowledge sources;

– integration of heterogeneous knowledge sources;

– implementation of an adapted appropriation regime in light of generating value.

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The success or failure of innovation will thus depend on the capability of firms to identify, select, integrate and value a great variety of knowledge sources, which are distributed inside and outside their boundaries.

Monitoring the internal and external environment

Adopting an open, interactive or collaborative innovation strategy supposes being able to identify the most promising internal and external sources of knowledge in order to seize innovation opportunities. During the invention phase, for example, the firms may not possess all the required know-how, knowledge or competencies. At the same time, they must acquire a deep understanding of the issues associated with the integration of a variety of technical (architectural and components knowledge, scientific knowledge) and non-technical (market and regulations knowledge) knowledge. This also supposes being capable of identifying the actors who possess experience in matter of collaborative project management, and who have a fine knowledge of the whole of factors (economic, juridical, technological, etc.) susceptible of having an influence over the innovation process. Two knowledge categories are thus particularly precious for the monitoring activity: a largely tacit knowledge enabling to identify the competent actors and a solid know-how applied to the management of interactive innovation projects.

Selection of knowledge sources

The monitoring activity logically orients the selection of knowledge sources and expertise, which seem to be most promising with regard to the aims and the constraints attached to the innovation project. One of the particularities of the selection process in interactive, open or community-based innovation projects is that participants are often chosen for their competencies not only as creators but also as future users of the innovative product or service. Let us take the example of the ARPANET network development (see Box 1.2). In the 1960s, the telecommunication market still lacked structure and the technical and architectural properties of a communication network could not be conceived with the aim of responding to stable needs or preferences. These properties first correspond to aspirations of the first users of the network, that is to say, the communities of scientists that participated in its development. The relative immaturity of ICT markets, especially the component market segment, largely motivated the adoption of a collaborative innovation strategy, directed, at first, toward the future users to develop the network. This strategy led the users/developers to create a new dominant design. In this context, the standardization of languages, protocols and interfaces prepared the development of commercial applications. Relying on the deployment of a community-based organizational structure for problem-solving, knowledge codification and favoring the distribution of documentation, the ARPANET project prefigured the models of innovation management today employed in the open source software (OSS) industry (see Box 3.2).

Integration of knowledge sources

Once the stakeholders and the knowledge sources have been identified and selected the project managers have the responsibility of connecting the whole of the resources, competencies, technologies and communities susceptible of contributing to its achievement. Those responsible for the project can organize formal or informal meetings throughout which the participants revise the different technical difficulties and the associated solutions. These reunions favor the dialogue and the development of problem-solving capabilities. This aptitude to the connection of communities is critical for the integration of knowledge. In practice, the development of interactive innovation supposes being able to manage a great variety of relationships between stakeholders each holding specific knowledge. Thus, we observe that, whatever the studied innovation model (open innovation, crowsroucing, community-based innovation or user-based innovation), the architectural relations on which the development of interactive innovation relies is generally rooted in a combination of formal (e.g. contractual agreements) and informal (e.g. interpersonal knowledge, reputation effects, trust) relationships. It is interesting to observe that the establishment of contractual agreements during the commercialization and appropriation phases is often reinforced by the existence of interpersonal relations and informal interactions between the stakeholders. The alignment of formal and informal relations particularly allows exploiting the virtues of the community-based forms of innovation governance, underlining the central role of coordination agents and support of knowledge communities (see section 3.2).

Implementation of the appropriation regime

The choice of the appropriation regime adapted to the innovation project not only concerns the commercialization phase. This choice is equally decisive during the upstream phases of the innovation project since it determines the conditions in which the generation and the application of knowledge operate (see Box 2.10). Two options are accessible to the firms engaged in an interactive innovation project: they can opt for a strong or weak appropriation regime, each relying on specific juridical protection mechanisms (patents, secret), technologies (product, process) and (tacit, codified) knowledge (see Chapter 2, section 3). The choice of the appropriation regime depends on the innovation project as well as the business model on which it relies. Whatever be the chosen model, the reciprocal trust that the innovation stakeholders nurture, as well as the perception they have of the economic profitability of the project, is strongly influenced by the adopted appropriation regime.

In interactive innovation projects, the appropriation regime will be more efficient when it protects the participating firms from the risks of appropriation of their strategic assets, on the one hand (limiting opportunistic behaviors from unscrupulous partners) and by facilitating the access to a variety of complementary assets situated outside the perimeter defined by their resource portfolio, on the other hand. The choice of the appropriation regime is then decisive for innovating firms since it conditions how they access and integrate the knowledge distributed between the partners.

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Index

A, B, C

D, E, G, I

K, L, O

P, S, U

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