Abstract
The strategic use of knowledge and its management depend upon the relevant organizational context. The model of the “learning ladder” is a compact way of describing the unfolding of multiple organizational knowledge creation, transformation and transfer processes in a single firm context. Additionally, in this context the governance of the firm internal knowledge processes is performed according to the resource-based view of strategy. In this paper two different contexts challenging such model are explored in the case of a large pharmaceutical company, AstraZeneca. First, the boundaries of the single firm are crossed by looking at those advantages, which may be attained by managing the transfer and co-production of unique knowledge between a few allied firms according to the theory of relational rents. AstraZeneca “formal network” is discussed in the light of this model. Secondly, emerging features of how knowledge is managed among a large number of interdependent organizations and individuals are explored with reference to the case of a very peculiar R&D department at AstraZeneca: Clinical Science. While in the first case the model prove to hold, in the latter context behaviours and performances seem to contradict the principles of knowledge management inspired by the resource-based and relational views. This is puzzling: conventional strategic and knowledge management frameworks break down precisely when dealing with highly distributed, knowledge intensive businesses.

1. INTRODUCTION

The problem of managing knowledge needs still to be set in fruitful terms before effective organizational and technical solutions are envisaged.

The well-known distinctions between various forms of knowledge, like tacit or explicit, individual and collective, are important but linked to viewing knowledge as a commodity that can
be managed independently from its context. We argue that what is relevant is also the specific interdependence between knowledge, organizational context and infrastructure.

It has been recognised that alternative ways to manage knowledge, including different systems to support knowledge management (KM) are required for different organizational contexts (Morton, et al. 1999). For example, consider the design and implementation of a new organizational arrangement, including the tailored change of processes, the introduction of teams and other empowering mechanisms, the deployment of systems and applications to enable a richer sharing of knowledge and so on. Suppose the new configuration of resources and policies fit perfectly the needs of the firm in question. On the other hand, consider a situation where that firm in order to access new knowledge or acquire new capitals for growth, is forced by market or technology circumstances to enter an alliance with another firm. The second firm will obviously has its own KM systems and practices, so that it may well turn out that the internal KM arrangements, resources and infrastructure of the first are too rigid, “closed” and incompatible to successfully meet the others.

We want to push the argument forward considering yet another set of circumstances: the knowledge intensity of the business may oblige the firm to become a member of a fluid community of institutions, organizations, and individual in which the very boundaries of the firm, its internal knowledge sources and flows, and relevant property rights are put into question and lifted up. It is obvious that KM practices and systems in these three contexts are bound to be different. Especially in the last case an orderly, fully controlled knowledge management policy will be hampered by multiple stakeholders, a fragmented, diversified infrastructure and the variety of knowledge sources. In such case, not only the boundaries of the firm become more porous, but also the tracking of the knowledge property rights may be cumbersome. We will argue that the transaction costs would be too high to manage such an open and knowledge intensive business by adhering to models valued for the single, closed firm.

In what follows we want to spell out the differences between the three main contexts in greater detail and their implications in relation to the learning ladder model. First, the model is presented considering the context of a single firm and its closed processes of KM as inspired by a resource-based view of strategy. Then, the alliance between a limited numbers of firms is examined with an explicit focus on the intertwining of previously separated KM processes and systems. At last, the most challenging context is analysed: a web arrangement of multiple business, independent research units and institutional entities. In such context knowledge does not belong fully to a single stakeholder, and boundaries are blurred. How to “manage” knowledge in this floating and rather undefined context?
The case of a leading pharmaceutical company, AstraZeneca, will be used as an illustration providing empirical evidence of the sophisticated maps where knowledge intense businesses cope with the complex challenges posed by the diverse contexts of knowledge management. We submit that the change of organizational context deeply affects the rules of KM, strategy, and infrastructure. Specifically, we will illustrate that an inverse relationship holds between the knowledge intensity of the business and the tightness of internal knowledge governance: what is functional and appropriate from a strategic point of view in the single-firm case becomes inadequate, if not dysfunctional, in the case of the web of organizations and institutions.

2. THE LEARNING LADDER: A MODEL FOR THE SINGLE FIRM

Consider first the single firm. In this context we focus on the processes of generation and transfer of knowledge as linked to a variety of internal learning processes. In highly situated ways, people learn by doing (Nelson and Clark. 1994; Nelson and Winter. 1982; Williamson. 1975) learn by using systems and technologies; at times they may engage in double-loop or radical learning (Argyris and Schön. 1996); or, more in general, they are busy creating new knowledge by socializing the results of learning, and converting explicit into tacit knowledge and vice versa (Nonaka and Takeuchi. 1995). In (Andreu and Ciborra. 1996) a "compact" representation of the main learning processes in an economic organization was put forward. Such a model can be a useful reference scheme for investigating strengths and weaknesses of organizational learning processes and, we submit, these can be of help in identifying key aspects of KM in a single firm. The model, called the learning ladder, is based on the resource-based view of strategy. According to this theory, at the heart of the firm’s competitive strength is a process that develops distinctive, core capabilities (Prahalad and Hamel. 1990) i.e. capabilities that differentiate a company strategically, and deliver competitive advantage (Barney. 1991; Leonard-Borton. 1992). Core capabilities develop through a series of transformations, by which standard resources available in open markets (where all firms can acquire them), are used and combined within the organizational context of a firm, to produce capabilities, which in turn can become the source of competitive advantage, especially if they are rare, and difficult to imitate or substitute. Such transformations are complex, situated learning processes, which can play a strategic role for the firm, because (1) they imply path-dependency and specificity in the resulting core capabilities; and (2) consequently, they cause their inimitability, a crucial characteristic for obtaining competitive advantage. Consider the major stages of the learning/ transformation processes through which the firm's core capabilities are generated.
A first transformation consists into the emergence of generic capabilities from standard resources. Two different types of learning can take place at this stage: one deals with mastering the use of standard resources, and produces efficient work practices (Lave and Wenger. 1991) Individuals and groups (communities of practice) in the firm learn how to use resources in a given organizational situation. The quest for better work practices may even trigger a search for new resources, more appropriate to the practices under development. Or, the introduction and subsequent deployment of new resources (e.g. technological innovations) may motivate individuals and groups to “take advantage of them” through new work practices. We call such a learning loop from resources to work practices the routinization learning loop, since its outcome are repertoires of constrained, routinized and interdependent actions or moves. The environment in which learning occurs is an organizational context that influences the learning process and is in turn influenced by its result (i.e., new working practices become part of the context, thus increasing the knowledge base of the organization). Such an organizational setting has the characteristics of a formative context. Work practices are “formed” within it, and receive their meaning and scope from it. Work practices resulting from this learning loop are concrete, detailed, specific and operative - in fact, they tend to lose their value when taken away from the specific situation in which they were developed and are since used. From a different perspective, work practices are the first step in the firm’s “internalization” of resources. Mastering the usage of a spreadsheet by an individual or a team in a specific department is an example of this type of learning.

A second transformation "abstracts" and “constructs” capabilities from existing work practices. Several characteristics connote this learning process: (1) it involves combining emerging work practices and organizational routines; (2) its outcome has a far-reaching potential impact, as capabilities convey what an organization is capable of doing if properly triggered in a variety of situations; (3) capabilities can be easily described in terms of what they do and how they do it; and (4) capabilities are more abstract than work practices: they are "skills without a place" which can be transferred across the organization (such as, for example, a quality control capability). We call this the capability learning loop. KM at this "lower" level results in a continuously improving

---

set of capabilities -specialized and idiosyncratic ways of using resources for given purposes. These purposes are functionally well defined and rather stable over time, although how they are attained may change, for example with the emergence of a radically new technology (resource), or a revolutionary new use of an old resource (Penrose. 1959). The driving force for continuous capability improvement is static efficiency. (Ghemawat and Ricart. 1993) Such learning processes tend to occur spontaneously, but the organizational climate and context, the incentive, power and motivational systems, and, last but not least, the technology, may deeply affect the learning process in different organizations. Although efficient, capabilities lack a sense of why they exist, or at least the reasons for their existence are seldom challenged. The "why" appears with more clarity as they evolve into core capabilities through a third learning loop. (See Figure 1)
Namely, capabilities can evolve into core capabilities, which differentiate a company strategically (Grant, 1991). There are two main factors, which contribute to the selection of which capabilities have the potential to become core: the competitive environment and the business mission of the firm. When faced to its competitive environment, a firm learns whether some capabilities have strategic potential (they are valuable, rare, etc.). A converse influence, from core capabilities to capabilities also exists through the competitive environment, as (1) core capabilities of different firms competing in an industry define the “standards of excellence” for that industry --, they can elicit which capabilities a firm should develop in order to compete.
effectively; (2) it is when confronted with a given environment that capabilities acquire a sense of why they are important, thus revealing more clearly their role and scope. A firm’s business mission is relevant for identifying the core capabilities because it sets priorities in the alignment between them and the current mission. In turn, core capabilities can enable new business missions which, if accepted, may trigger new "capabilities - core capabilities" transformations. These interrelationships are captured by the strategic learning loop, which links capabilities and core capabilities (see Figure 1). Note that also the strategic loop takes place within the firm’s organizational (formative) context, and so it is "structured" by it (Giddens. 1984). On its turn, its outcome - core capabilities- can reshape the context itself. This subset of capabilities can be described and understood not only in terms of what they do and how they do it, but also in terms of why: we are in the realm of dynamic efficiency. For example, changes in the environment can make a highly efficient (in the static sense) capability worthless, because it is irrelevant for competing under new circumstances.

Finally, consider how organizational inertia can limit learning. To drastically change the context where learning takes place is a difficult endeavour, although sometimes necessary - for example to respond to radical shifts in the environment and/or business mission. However, radical changes in the business mission are not likely to occur, as its definition and meaning correspond closely to a given organizational context. Revolutionary changes in organizational context or business mission require radical learning, for example, becoming aware of what the extant context is and explicitly stepping out of it in order to innovate (Argyris and Schön. 1996).

In sum, the ladder involves three main learning loops. One basic loop routinizes work practices, and indirectly routines, while using resources; a second one combines work practices and organizational routines to form capabilities; and the third gives meaning to capabilities in the context of the firm’s competitive environment and business mission, thus allowing the selection and elicitation of core capabilities. The knowledge of which capabilities are distinctive and fundamental to compete is strategic in nature and becomes part of the organizational (formative) context in which all firm’s activities, including learning, occur. Changing such a formative context may involve a fourth (double-loop) learning process.

The KM implications of the learning ladder for the single firm case are quite straightforward. While in the routine learning loop the spontaneous unfolding of tacit knowledge takes place, routinization implies the systematic effort to make larger portions of this knowledge explicit for repetitive use. Thus, we find KM practices trying to strike a balance between robust, but implicit routines and routines that through formalization become standard operating procedures.
Information systems can be used in various ways to enable such processes. For example, groupware applications can enhance the informal transfer of knowledge within specific communities of practice or teams. On the other hand, workflow applications can deal with the more formalized steps of the tasks being performed. Finally, ERP applications take care of cross-functional and interdependent procedures.

More in general, we can look at KM as an activity dedicated to the transfer of useful knowledge embedded in routines throughout the organization, that is, it takes care of the cultivation and diffusion of competencies, and their selection and alignment with the prevailing business strategy. Various mechanisms can be deployed to this end. In particular, BPR and ERP can be harnessed to formalize and “freeze” capabilities into standard ways of operating. But capabilities cannot be put into software alone: organizational and educational processes may be also necessary. KM related to core capabilities focuses on creating opportunities for identifying the most competitive matches between capabilities and an adequate reading of the market, and the environment in general. KM should be dedicated to create occasions for the effective mixing of inside and outside knowledge. Intelligence systems can be one important resource in this respect, together with the singling out of individuals and teams who possess “boundary spanning” roles and capabilities. Finally, KM for radical learning consists in staging activities and settings conducive to reflection in action by the key members of the organization. Education and outside consulting expertise can also play a decisive role. Attempts have been made to use simulation packages aimed at enhancing systems thinking and learning in action (Senge. 1990).

In what follows we discuss these themes, and challenge the learning ladder model in two different settings where the boundaries of the single firm are crossed. The first is an inter-organizational setting, the second one a web of organizations. We illustrate how the model is a valuable framework in the analysis of the first setting, and how it can be proved to be of use in avoiding unpleasant surprises as a partnership develops over time. The web form, on the other hand, illustrates a setting where models for planning and managing knowledge do not hold. Both cases refer to knowledge management systems adopted by the pharmaceutical multinational company AstraZeneca to support the R&D process in its different phases. AstraZeneca is a major international healthcare business engaged in the research, development, manufacture and marketing of ethical (prescription) pharmaceuticals and the supply of healthcare services. As we will see such processes are complex, costly and time consuming. AstraZeneca is one of the top five pharmaceutical companies in the world with healthcare sales of $16 billion and
leading positions in sales of gastrointestinal, oncology, anesthesia including pain management, cardiovascular, central nervous system and respiratory products.

The year 2002 has brought the company a significant challenge as the patent over its gastrointestinal drug Losec® expires. The ulcer medication is in fact accounting for a full 40 percent of AstraZeneca's $16 billion in drug and health care sales. To respond this challenge new R&D processes were designed and new organizational solutions were implemented.

3. BEYOND THE BORDERS: INTERORGANIZATIONAL LEARNING LADDERS

What happens to the learning ladder and to the related KM policies when two or more firms adopt a cooperative strategy and engage in some form of alliance (ranging from joint venture to merger)? In a successful alliance it is likely that the learning ladders of the partners will intertwine, almost like a DNA double helix (in the case of two firms): in this way knowledge gets shared across separate organizations and new knowledge is developed in the process. The learning ladder remains a useful tool to depict the ways in which such knowledge sharing and developing processes take place and to reflect on how they should be managed (see Figure 2).
Again, the teachings and models coming from business strategy can be of help in analysing the opportunities and outcomes of the recombination of separate knowledge processes and stocks. Specifically, the “relational” view of the strategic advantage coming from interfirrm links and resources offers interesting insights. (Dyer and Singh. 1998) While the early resource-based view of strategy focuses on the advantage generated by key “core” assets and capabilities, the frequency of alliances, especially in very dynamic and innovative sectors, suggests that there is another source of competitive advantage. This stems from the establishment of unique inter-firm linkages, which in themselves can become a distinct source of relational quasi-rents. In other words, the firm’s valuable resources do not necessarily lie only within its boundaries. They may extend beyond them. The recombination of separate learning ladders becomes the paramount mechanism through which one can see how new knowledge, routines and competencies are uniquely produced and exploited by the allied firms.

Under normal, arm’s length market relationships, learning ladders of separate firms do not mix. Knowledge is transferred from one ladder to the other through intermediaries who trade services and products available through the market. Standardized goods and services which embed knowledge (Demsetz. 1988) are traded with minimal communication (i.e., the price) across separable technological and functional interfaces.

Successful alliances, instead, transform standardized relationships into unique ones through various mechanisms, such as investments in relation-specific assets and infrastructure; recombination of capabilities and routines; developing distinctive know how; establishing a common experience and joint practices; or developing a new jointly spoken language that facilitates co-operation. All these mechanisms favour the non-market transfer and recombination of knowledge. For example, close partnerships with lead users create significant opportunities for the improvement and re-invention of products and services (Von Hippel. 1994).

The learning ladder can become a tool to better identify such processes already pointed out by the R & D and innovation literature, and highlight relevant management issues. Interlocking learning ladders can generate value in various ways. The interlocking ladders show where the potential for knowledge sharing, recombination, and transfer is. Valuable know how can be attained by mixing/transferring capabilities; by placing resources and routines within new contexts; or by letting existing practices being moulded by different capabilities to form new routines.

To be sure, governance is paramount in securing compatibility, transferability and value generation. At first, effective governance must look for a smooth interlocking process. Various
aspects must be taken care of by asking questions such as: is a core competence of one organization compatible with the other firm’s formative context, portfolio of competencies, routines, systems and resources? Second, can it be transferred to the other firm? Finally, can it lead to new mixes with existing resources and routines leading to new combinations, to the generation of different practices and knowledge? One can try to ask these questions systematically as shown in Figure 3, and come to conclusions for every relevant cell in the table.

<table>
<thead>
<tr>
<th>Formative Context</th>
<th>Core Capacity</th>
<th>Capacity 2</th>
<th>Routine 2</th>
<th>Work Practice 2</th>
<th>Resources 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formative Context 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core Capacity 1</td>
<td>Compatible ?</td>
<td>Transferable ?</td>
<td>Innovation ?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routine 1</td>
<td></td>
<td></td>
<td>Compatible ?</td>
<td>Transferable ?</td>
<td>Innovation ?</td>
</tr>
<tr>
<td>Work Practice 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resources 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Compatible ?</td>
</tr>
</tbody>
</table>

Figure 3. Governance questions for the interlocking of two learning ladders

Once having verified this basic level of interlocking, specific aspects that may lead to relational rents should be considered. Examples are: uniqueness of the matching (due to partners scarcity or special bundling of resources); time required to achieve the fusion between the ladders; institutional factors that may favour a certain type of combination, etc. The interlocking of the ladders provides a map, like the “double helix”, that points out key aspects for the governance of those knowledge transfers that can be the source of relational rents. Systems can play a crucial role, too. First, at the infrastructure or sheer resource level issues of compatibility, and data
transfer emerge immediately. Many ERP or legacy systems may actually block the implementation of alliances because of incompatibility. On the other hand, IT is a resource that can be creatively re-invented by adopting another organization’s competencies thanks to the alliance. Or, the infrastructure might act as a carrier of a formative context, not only of procedures: this can have a deep and wide-ranging influence on the practices and routines of the other firm. These various possibilities may impact the level of actual collaboration between firms having different systems.

3.1. THE DOUBLE HELIX GET COMPLEX AND COMPLEX

It is straightforward to picture how this model can be adopted to analyse a case of a two-firm relation. On the other hand, the case we consider in this paragraph is more complex in terms of number of firms involved. However, even if the complexity has increased, the model can still be applied and unfold how single firms are interacting and creating a network of relations. The network considered is the inter-organizational network settled by AstraZeneca R&D during the development process of a new pharmaceutical product. As we mentioned, AstraZeneca is a strong research-driven organization engaged every year in developing effective products for a large range of serious diseases. The inter-organizational network, generally speaking, consists of a set of relationships and partnerships that AstraZeneca establishes with external suppliers. Drug development requires in fact network presence since it is a process integrating several different kinds of highly specific and distributed knowledge.

In the last decade the pharmaceutical industry has seen the proliferation of the so-called Contract Research Organization (CRO). These research organizations are supplying part of the drug discovery process to the pharmaceutical multinational companies. Since the beginning of genomic research programs pharmaceutical companies are increasingly outsourcing part of the discover-development process to CROs. As already discussed, this strategy is related to a problem of knowledge production and exchange. However, most recently, knowledge in the biological science has grown and involves so many different disciplines that it is almost impossible for a specific R&D laboratory to keep up to date with all this complexity. Accordingly, the discovery process in the pharmaceutical industry is increasingly affected by the progresses in basic research. Therefore, it is unsurprising that there is a huge increment in the number of contractual relationships between pharmaceutical companies and academic/non profit laboratories (Pisano, et al. 1988; Tapon and Thong. 1999). To invest in the internal development of chemistry, biologic, microbiologic and genomic competences, only to cite some of them,
would result in a worthless and resource consuming effort. The requisite knowledge is so wide in the range and at the same time so specific in its sub-entities that only specialized organizations can produce it. At the same time, being the new drugs so different in the requirements, they need new experimentation methodology and hence skills. This new knowledge cannot be easily and strategically deployed internally\(^1\), but has to be found outside the borders of the organisation.

These reasons for having a network structure are related to the high complexity of the drug development process. A drug is a chemical substance affecting human body and its creation is closely monitored and strictly regulated by national and international authorities. Its development process takes from 12 to 16 years during which candidate drugs go through several phases of analysis and tests concerning a wide range of scientific areas as chemistry, microbiology, statistic, biochemistry, medicine, pharmacology, quality of life, psychology and others. University, independent laboratories, biotechnology firms, hospitals, statistical institutes and other actors are nodes of these networks. They broaden the range of exploratory research and allow access to a wider base of scientific and technological knowledge.

Strategic partnerships can take many forms as research collaborations, licensing or acquisition agreements, or outsourcing of particular analysis. They can also cover limited part of development processes or be present during the whole process from early stage in the research to the launch of the product on the market. It is a strategy driven by goals of cutting costs, speeding up the time-to-market, having strategic access to innovative biotechnologies. Creating a partnership with a biotech company, for example, could mean to have an early and reliable access to emerging advanced technological products, as instruments or services, before they are on the market. Such partnership could imply that scientists in different therapeutic area in a pharmaceutical company could take full advantage of this unique technology platform and expertise. This means first of all innovation and faster pace of development.

Time-to-market is actually the most critical factor of the pharmaceutical industry. The industry is in fact strictly regulated by the patent system, which assures a quite limited period of market exclusivity, about 20 years out of which minimum 12 to 16 are spent on development. Speeding up the process implies longer exploitation of revenues guaranteed by the patent and consequently larger incomes.

The other critical factor is related to innovation. Pharmaceutical company focus is on advanced enabling science and technology methods such as informatics and genetics. The sector is in fact living in a regime of rapid technological development due to progresses in chemistry, technology, biotechnology and in particular in pharmacogenomics, the science that studies the relation

---

\(^1\) for a exhaustive explanation of the strategic reasons see Tapon and Thong, 1999
between human genes and diseases. It is fundamental for large pharmaceutical company to create
contacts with small-specialized laboratories and firms offering highly qualified technologies.
Innovations, moreover, are becoming increasingly interactive, requiring networking across
scientific community. The knowledge needed for innovation is distributed both within the
organization and across organizations. In this situation the knowledge must be continuously
negotiated through interactive processes and the company must possess the capability to
maximize the value of its contacts.
An example of such inter-organizational set comes from the documentation of a particular drug
development process that has taken place at AstraZeneca, and it is now successfully concluded.
During this development process several relationships have been employed. AstraZeneca, as
central node, coordinated the network fitting external and internal knowledge processes and
stocks in a unique drug development process. A node of this network has been an independent
laboratory of research situated in Germany called Institut für Klinische Pharmakologie. This
relationship concerned mainly the Phase I of the drug development process. Specifically the
phase is the first one of the Clinical Studies where the candidate drug is introduced into humans.
This phase is designed to determine metabolic and pharmacological actions of the drug, side
effects associated with increasing doses and to gain early evidence on effectiveness. To be a
relatively small laboratory of research means be able to develop specialized knowledge in a
defined area of medical research: thus developing experience with the latest techniques in the
field combined with constant upgrading of competence, infrastructure and professional know
how. AstraZeneca has started this collaboration giving access to information and data from
previous Pre-clinical studies as knowledge on safety and chemical activity of an active
compound.
The institute developed Phase I of the process. Although the process is described in terms of
phases, development is really a continuum of research: the phases are not sharply differentiated
and several studies are done at the same time for different purpose. For instance, after advanced
clinical testing on adults there could be sought a paediatric indication. In this case a new phase I
will start. Thus the knowledge created during the various phases pf the process must be
continuously shared with all actors involved in developing and recombined with already existing
knowledge. Even if the research laboratory is a node in the network, it is constantly part of
processes of recombination for developing the new pharmaceutical product. The considered
relationship does not deal with goods or services that could be sold and moved from one firm to
another. The specificity and knowledge intensity of the product requires collaboration on its
development. Collaboration means integration of efforts on compatibility pieces of knowledge.
Applying the learning ladder model and questioning its interlocking process for each of the relations of the network, provides insights for an understanding of the dynamics of the relations itself. These insights are valuable when managing a partnership and particularly when evaluating its competitive advantage.

In addition, all the activities deriving from the ladder interlocking process are bound, by their very nature, to be collective, in the sense of involving always more than one individual. In such a situation, collective learning and knowledge become paramount. As Andreu and Sieber (Andreu and Sieber. 2000) point out, one important kind of collective knowledge has to do with coordination schemes, fundamental to put collective action (routines, for example) to actual work. Furthermore, coordination schemes are often implicit, with the implication that their development and transfer must be based on processes that can not be easily formalized and codified. The issue is further complicated by the fact that the routines and capabilities to be coordinated come from different contexts. This puts even more pressure on the corresponding coordination schemes. Other collective bits of knowledge and capabilities have to do with how individual decisions or visions are integrated into group decisions. All these aspects point out areas where innovation, in the sense of generating new routines and capabilities of a collective nature, will probably have to be carefully considered. As suggested by the third type of questions shown in the table of Figure 3, it is not only a matter of compatibility or transferability, but of how compatible and transferable practices, routines and capabilities coming from different firms can be newly combined and coordinated. To be sure, systems can help to achieve this; for example workflow-based applications and communication infrastructures can contribute to set the basis for coordination, but only to the extent that the latter can be made explicit and codified.

4. FROM THE LEARNING LADDERS TO THE LEARNING COMMUNITY

In the previous sections, we have illustrated the learning ladder model and how it behaves when it comes to the analysis of an interorganizational setting. These network-like settings are rather common in knowledge intensive industries, for instance in form of alliances. Typically, firms in technology-sophisticated industries, as telecommunications, software and pharmaceuticals, may execute every phase of their activity through some form of collaboration. Thus all functional areas are affected: from production to R&D, from marketing to distribution. Consequently, as we have seen, in those industries companies cooperate with private research labs, universities, institutions and other firms at the same time (Powell. 1967).
However, the emerging networks of knowledge intensive firms are much more complex and intertwined than a cluster of few, even if large, companies. These networks have a different shape and require their own coordination and governance mechanisms. The aim of this section is to explore one of such networks with an explicit focus on its knowledge behaviours and performances.

In the analysis of these emerging networks it becomes more and more difficult to identify distinct clusters of re-combined learning ladders. It is hard to separate the strings and their connections of this entangled, spaghetti-like configuration of resources, practices, routines and capabilities derived from the fusion of knowledge inputs being provided by the various participants. That is, knowledge creation or re-combination occurs among the members of a fluid community composed of very different organizations. The hard-to-distinguish spillovers or overflows (Callon. 1998) of know-how prevail in number, volume and importance over the planned or managed transfer of knowledge (Steinmueller. 1995). Transfer is superseded by spillover through interstices. Spillovers are the knowledge by-products of activities and modes of operating of the participants. Just by being immersed in this flow and breathing its “atmosphere”(Marshall. 1930) one can tap in this invisible social knowledge capital generated by the very interaction between multiple participants. Computer networks like Internet, or the ubiquitous mobile phones facilitate such informal sharing, and the rapid, uncontrollable spread of spillovers. Finally, “boundary objects” (Star and Ruhleder. 1996) like standards, systems or applications which are widely exchanged or used by the members of the community constitute an important “knowledge infrastructure”(Steinmueller. 1995) that further enables the efficient exchange and re-combination of new knowledge coming simultaneously from multiple sources and flowing to other destinations.

As for individuals, here learning takes place through the practice of membership in such evolving community (Brown and Duguit. 2000). However, it is hard to locate precisely the know-how. Knowledge is simultaneously highly sophisticated (both tacit and explicit) and widely dispersed, in the hands and minds of many, not easily produced or captured inside the boundaries of one or few firms. Rare knowledge is neither located inside the organization, nor reliably available for purchase through the market (hence the two main mechanisms for transfer of knowledge listed by Demsetz (Demsetz. 1988)seem to fail: only the one based on educating and learning obtains, but at a community and informal level).

To illustrate such fluid context, we consider the second case from AstraZeneca.

4.1 THE LEARNING COMMUNITY: ASTRAZENECA
As mentioned above, during the last decade important changes in the drug discovery process and experimentation have occurred. In this new environment, biotechnology and genomic research have become typical fields of investigation. To achieve the necessary knowledge in these fields is neither easy nor simple. To successfully face this challenge the pharmaceutical industry is moving progressively toward a web of organisations that are co-producing knowledge. The knowledge required in the R&D department cannot in fact be entirely produced inside the internal departments or simply bought at the market. It has to be co-produced in a complex relational network (see below). The cost of knowledge creation can be minimised outsourcing part of the process, but to manage this externally produced knowledge required a big effort in terms of coordination and recombination activities. Less knowledge is produced internally, but, as a consequence, more and more knowledge must be managed to fulfil the knowledge creation needs. Therefore, the R&D department is increasing becoming a collector and re-combiner of knowledge produced by the company’s partners.

To successfully accomplish this new task, a vast knowledge about a broad area of activities is required, so that it is possible to understand all characteristics proper to the knowledge produced outside the organisation. The knowledge necessary to manage this situation is thus non-specialised knowledge, but specific knowledge about the broad span of areas. To manage the R&D process is increasingly becoming the management of a loose-coupled system defined by a large number of independent elements with a very detailed knowledge of their specific area of research. They know their environment to an higher degree than the more tightly coupled system that has a less sensible understanding of the local environment (Weick. 1976). Loose-coupled systems are also more efficient in facing high dynamic and open environments.

Within the R&D department of AstraZeneca, a new unit has been organized to accomplish this new task, as well as with the more explicit aims of speed up the drug registration process and to increase the success in the overall procedure. This unit is called Clinical Science and is meant to provide scientific support to the R&D process. The unit is divided into the following areas of intervention: Medicine & Science; Quality of Life; Statistics; Epidemiology; Health economy.

The task of each group is to support drug discovery, experimentation and registration process and to improve the quality of the overall R&D progression making it faster and with fewer errors. The different groups are organized on the basis of various schemas. It can be extremely flat as with Health Economy, or with a semi hierarchical structure as with Statistics. The common underlining aspect of the groups is the members’ high educational level. On average, the people employed at the Clinical Science department have a PhD. in the field of competence.
The task of each group depends on the specific capacity, but they all support and advice the drug development process. They are the advisors of the drug project during its exploitation. They provide the very specific knowledge in form of advice or answers, that supports the solution of the most unpredictable adverse events happening as the process develops. Sometime the problems have already emerged in other similar cases. Otherwise, very often, the problems are unique. They have to be solved from scratch and on the base of new frames of references. The necessary solutions are unpredictable and they cannot be solved implemented routines based solutions. In order to be able to carry on the development, problems need the construction of an ad-hoc answer that has to be discovered time by time. Highly educated people are employed in the unit to solve these kinds of unexpected events. When the new drug project is set up, the different experts are assigned within their own specific tasks for the drug’s specific needs.

The solution to the emerging problems is, in this case, provided on the bases of the knowledge the experts have and are able to collect. An expert is working relying on her/his personal network which is mainly based on external knowledge providers uniquely known by the expert herself/himself. During fieldwork, it has emerged that this is one, if not the main reason why a Ph.D. degree is required in order to be part of the department. Usually owning a Ph.D. means to have research knowledge, i.e. knowledge about the resolution of unusual problems, but also to have a network of references. This network of references, represented by other researchers, research laboratories, universities and more in general by the scientific community, is the network used by the members of the Clinical Science department to perform their daily work. They become the re-combiners of the knowledge produced through this network and hence they become the project’s gatekeepers for knowledge.

The different groups in the departments work in projects that correspond to the undergoing drugs experimentation at AstraZeneca. The project leader, acting as a coordinator of the R&D process for the specific drug, has to monitor and thus to coordinate the recombination of the knowledge provided by the single experts in a way that guarantee the success of the drugs development process. The project leader drives the project on the basis of the information she/he gets from the experts supporting the project. She/he has to understand the information provided and discussed in the project open forum. She/he has to decide the future of the drug experimentation process. Accordingly, she/he has to manage a broad amount of different knowledge that are needed to support the experimentation phases.

The projects lifetime is very long, varying form 10 to 15 years, and many decisions must be taken during its span. Not all the projects culminate with a successful introduction of a new drug on the market. Only a few drugs reach this stage. The project leader has to understand when and if the
project has to be stopped. If the information she/he gets from the experts during the testing phase is highlighting problems or mismatches with the forecasted plan, the project leader has to decide whether to go on with the project. During the drug development process many of these important decisions have to be taken. They are based on the information that the experts are continuously giving in the project weekly scheduled meetings.

The project leader bases her/his decisions on the recombination of the information that the single experts have provided on the basis of the personal network, i.e. through the collection of knowledges produced outside the organisation borders. She/he must thus have a generic knowledge about the different knowledges involved in the project. She/he must understand the information she/he receives on the basis of her/his specific knowledge about the broad problematic of drug discovery projects. She/he has to manage this complex knowledge and thus transform it into an organisation move (Pentland, 1992).

Several features of this case relate to KM and relevant organizational aspects. First, in a knowledge intensive business, one can get a quality service/product not through hierarchical organization, but through a highly dispersed community of knowledge workers (who, however, know well the overall structure of the product). Principles like Brook’s (Brooks. 1982) one-man month (adding another resource to a software project cuts down completion time only marginally) do not apply to a loosely connected, floating large number of researchers. In this new context, instead, an added person means extra capabilities to identify and solve the problem. In this loosely organized community there are no strict and explicit economic incentives at work, rather symbolic ones: for example, to be recognized as a competent and high skilled person in the research community. Sophisticated and innovative knowledge sharing mechanisms have been put in place, too. The formative context that moulds such KM devices seems to be more inspired by the atmosphere of an academic and scientific community, rather than a profit-oriented business organization.

In sum, the development of new drugs challenges many of the economic assumptions that underlie the economics of strategy and organization, especially for knowledge intensive, not fully commoditized businesses, where communication, coordination and distribution of competencies exist and there are serious problems of robustness, reliability and scalability. In particular, the case highlights that:

- peer groups of a very large size can function without being bogged down by coordination and communication bottlenecks (thanks to the Internet and ad hoc coordination tools);
- simultaneous or asynchronous work can take place without the need of strict sequencing or planning;
- opportunism and free riding do not seem to emerge as major issues that undermine efficient coordination. Symbolic rewards, altruism and a gift economy seem to hold instead (Raymond, 1999);
- private property of the final product is not an issue, either. There are alternative business models, whereby gains can be obtained through the provision of complementary services;
- hierarchical organization does not need to come into the picture to replace a team (Alchian and Demsetz. 1972); or a market arrangement(Williamson. 1975).

A new drug is developed by a large group of peers coordinated by a “knowledge gatekeeper” that re-embed (Giddens. 1990) the outside produced knowledge into the organisation.

The upshot is that such an organization can defy some of the principles that keep together traditional hierarchical organizations. From a KM perspective what emerges is an organizational form that is able to tap on the brainpower of entire communities; it is not territorial and fragmented; and it is not secretive and hostile, nor plagued by opportunism. The principles of “divide et impera” and “knowledge is power” which are pivotal in hierarchical organizations do not seem to have a significant impact here(Fransman. 1996). There are further peculiar differences. For example, from an economic perspective, the discussed drug development process is in contrast with the evolutionary theory of the firm(Nelson and Winter. 1982). Such a theory takes for granted, on the basis of the feedback principle that the firm is a repository of routines (embedding knowledge and skills) hierarchically arranged: short run routines take care of operations; investment routines and higher-order routines modify over time the lower operating routines. The AstraZeneca case shows that a productive, and knowledge intensive “organization” can literally consist of a knowing community, where one can identify routines and skills of the members, but these, despite their large number and the feedback processes going on all the time, are not hierarchically arranged.

To be sure, the resource-based view of strategy falters as well in this new context. According to such a view a firm is seen as a repository of know how and its competitive advantage is seen deriving from the possession of that know how (the firm knows better than other firms how to organize work). Scholars point out that the distinctive competence of the firm would consist in those organizational capabilities able to organize, merge and govern activities (or lower level operating routines)(Dosi, et al. 1998). Instead, thanks to the new infrastructure, the knowledge intensity of the businesses and the very nature of the business itself (pharmaceutical R&D) the
notion of firm as a hierarchy of routines does not hold, if not as an inefficient organization (plagued by the negative consequences of Brooks’ principle).

Consequently, we are facing an altogether different business model, where the principles of doing business à la resource-based view of strategy seem to be turned upside down. The cases of drugs development at the AstraZeneca and the role played by the scientific community is not confined to the pharmaceutical industry only. One can find similar configurations and dynamics also in other research environments, like the Linux operating system development, Internet and or nuclear physics. Once again, in contrast with the single firm and its closed R&D, focused on control over territoriality of results, practices, and tools, we can observe across the boundaries of the firm and its R&D activities an analogy with the industrial districts (Marshall. 1930; Richardson. 1972), where synergy and atmosphere caused by diffuse knowledge and available to the members of the district benefits everybody. Such knowledge is the side product of a web of informal and unpredictable knowledge spillovers.

5. CONCLUSIONS

In this paper we have used the learning ladder model in order to examine which KM and governance approaches are more appropriate in order to foster the development of key capabilities to achieve competitive advantages in different organizational settings. While in the case of a single firm the implications are straightforward and even well known, in the other two cases analyzed, namely the interorganizational and community settings, the implications are less obvious and eye opening.

In the interorganizational setting, although consistent with ideas already set forth in the mergers and alliances literature, the learning ladder model provides a framework from which useful insights can be derived. New sources of distinctive competitive elements emerge if one assumes a relational view of strategic advantage, which conceptualises them as rooted in unique interfirm linkages. The framework provides a basis for a detailed analysis, taking into account how the components of different learning ladders in various firms fit or don’t fit. In addition, realizing that the interfirm case inevitably involves collective processes makes apparent that a new dimension has to be taken into account also at structural level. We submit that the role that systems, applications and technology can play in the corresponding processes may be better analysed in the context of the proposed framework, than is the common practice of today, where usually
partnerships bring along surprises regarding the incompatibility of resources, skills and systems, besides cultures. Looking at the intertwined ladders can finally help the difficult task of governance of the partnership, from a distinct KM perspective.

Finally, the knowledge community case, for which examples begin to abound in knowledge intensive industries, involves “spillover” processes rather than planned or managed transfers of know-how. This third setting suggests an interesting oxymoron: precisely in knowledge intensive contexts, knowledge creation, deployment and application for the purpose of attaining a sustainable competitive advantage seem to be less rooted on the basic principles that contributed to conceive knowledge as a fundamental source of advantage in the first place. In addition, when “digital goods” are involved, some principles of the “new economy” may apply, in particular increasing returns to scale both in the demand and the supply side. More research and better models are needed to pursue this case further, but the puzzle is served.

References


