Some Basic Questions about the Notion of "National System of Innovation"

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【Abstracts】

This text aims to question some basic concepts, developed in the frame of "national system of Innovation", such as institution, capability, routine, information and knowledge. For this, we will mobilize the "societal approach", conceived at LEST Laboratory, which put the accent on the interaction between actor and space and the interdependence of actors in their action. In particular, our approach will draw attention to the importance of three question: 1) level of analytical focus; 2) contextualization of space in which actors play; 3) articulation of macro-social and micro-organizational.

【Keywords】

Innovation, National System, Societal Approach, Actor, Competence,
Knowledge Transfer, Coordination, Routine

Introduction

Following the literature on the "national system of innovation" (Nelson & Winter 1982), many studies have shown national "profiles" of innovation structure that all stress the importance of interactions between the various elements of the systems involved (public and private research bodies, higher education establishments, government policies, firms …). The aim of this paper is not to cover the overall literature about the notion of "national system of innovation", but to call into question some concepts utilized in such a literature. In particular, we will try to propose to clarify such concepts as the institutions, organisations and actors involved in innovation -often taken for granted in the innovation literature- with regard to the "Societal Approach" -Lest approach (Lanciano, Maurice, Nohara, Silvestre 1992)- attempting to systematise the links between the construction of the innovation space in firms and the various spaces with which it interacts (the educational, industrial, scientific spaces).

In this paper, we will put the accent on the three dimensions of innovation: the production and circulation of skills and competences, the production and transfer of knowledge and the coherence of innovation systems. Then we will organise our argument around four themes which seem to have a fundamental importance in the innovation literature:

- What meaning of innovation should be

adopted?

- What meaning should be given to terms such as knowledge, competences, capabilities, learning, etc.?

- How should the actors, organisations and institutions be positioned in the whole scheme of innovation systems?

- How are the various levels of analysis - national, territorial, sectoral, the firm (particularly multinationals) - to be articulated?

I - THE DEFINITION OF INNOVATION

Innovation is self-evidently multidimensional and goes hand in hand with changes in the organisation and institutions in which the actors' strategies unfold. This is why any partial approach to innovation, focusing, for example, on the strategy pursued by any one of the actors involved, remains partial when it comes to drawing conclusions, since very little in the way of general lessons can be derived from it. At the same time, however, holistic approaches to innovation do little to make good this deficiency. Such approaches frequently lead to the definition of an institutional environment that guides the decisions taken by any of the actors, who are reduced in consequence to mere agents; as a result, they plot only a fraction of the coordinates of an actor seeking to solve problems and redefine his system of constraints before eventually managing, more or less convincingly, to reconstruct his action system, which remains immersed in an environment made up of organisations and institutions.

The various theories of innovation proposed until now tend to erect a two-level topology. In the first of these levels, the aim is to define the advantages acquired through innovation in order to confirm its necessity and encourage initiatives. This point of entry has the advantage of clarifying the gains made through innovation, but provides no information on the trajectory of the organisation or actor that has experienced a change classified as innovation. The second level consists of an analysis of the various processes of innovation. This may have several dimensions: technological, strategic, organisational, social and institutional.

Outlining these two levels of investigation leads us to pose several questions on the emergence of innovation as a fully-fledged analytical category. If this category turns out to have a meaning that is as precise as it is comprehensive, it then becomes necessary to define research protocols through which a plurality of dimensions as well as centrifugal motions can be captured. For example, if technological innovation has an institutional dimension, its qualities of technology selection must then be characterised.

I-1. Innovation as outcome

Research into innovation is still driven largely by a desire to identify ways of enhancing firms' competitiveness. In this sense, innovation is not a monolithic phenomenon but pertains rather to economic and social units competing with each other in specific contexts. As a result, innovation reflects the need to remain on top of the requirements and constraints that structure these various contexts. Thus, several types of innovation can be identified, not all of which require the same degree of effort. If the

effort expended is considered longitudinally, it can be seen that the drive to innovate is immersed in force fields that go beyond the confines of the firm. We will take these two stages of analysis in turn.

I-2. Innovation: staying ahead by changing

Not all innovations are equal. Some are the result of short-term investments, others are a matter of a firm's survival. Thus, a distinction can be made between several types of innovation involving very different degrees of change. Innovation may relate solely or concurrently to product, processes or organisational structures. It may be the outcome of a deliberate strategy adopted by a central management seeking to establish a new relationship with the market, with its competitors and its partners. However, innovation is often also the result of not entirely explicit processes that will gradually affect the competences of all or some of the members of an organisation. Innovation is also the product of several sorts of investment within the firm. R&D is not the only source of innovation: it can be produced at all levels of the firm. One of the most important aspects of these processes seems to be the chaining of decisions. It is appropriate at this point to note the relative weakness of studies of the internal diffusion of innovation, which often has its roots in a precise locus within the organisation but can only become established by being taken up elsewhere and thereby gaining acceptance. This process, termed "intraprise" by Burgelman and Sayles, simultaneously establishes the definition of a tangible new entity (product, process, clients) and the advent of a new activity (a new relationship of the organisation to itself). This type of analysis has the advantage of establishing a diachronic link between creative phenomena and power within an organisation.

Thus, innovation does not so much confirm the pertinence of objectives laid down ex ante as transform the actual working of the organisation. As a result, the meaning of innovation becomes synonymous with that of the organisation itself. True, innovation produces performance (market share, productivity, profitability), but the outcome in the long term cannot be confined solely to improved performance. If innovation ensures firms' survival, then we are obliged to investigate the conditions under which successive transformations can occur. It would seem that the resolution of a succession of problems (new relationship to market, new resource allocation system) is driven by a continuing quest for knowledge (Nonaka & Takeuchi, 2005). This way of looking at innovation as the outcome of a search for knowledge by and in the organisation has several advantages that are not always perceptible or accepted because they represent an implicit challenge to firmly established approaches. One of these advantages is that the firm is located in an environment made up of institutions that produce knowledge. These institutions are characterised not by fluidity but by contextualism, specificity even. A firm can appropriate knowledge only at the cost of a painstaking process of investment. Another advantage of this approach to innovation is that it breaks up the apparent unity of the firm as the sum of individual knowledge. Here again, contexts are given greater

weight than transactions. And one begins to wonder about the multiplicity of regulatory systems that make it possible efficiently to implement an activity that has its origins in the exploitation of knowledge embodied in individuals operating within professions and occupations, making choices driven by a range of incentives and taking decisions within a framework of collective activity.

In these various ways, therefore, innovation is immersed in a tangle of diverse rationalities.

I-3. The immersion of innovation

Lot of empirical studies reveal the important systemic aspect of innovation. Innovation is the result of the actions taken by an entity reacting to stimuli from surrounding entities. The national systems approach to innovation attempts to describe the internal movements of the systems. Although we did not present a detailed genealogy of the notion of (national) innovation system, mention must be made of the objective links between this approach and the technical systems developed by Bertrand Gilles (1978), among others, and the technological strategy systems highlighted by the "technological clusters" school (Gest). In both cases, the aim is to construct a theory that can be used to analyse a system in which the various elements are organised on the basis of a "majority interactions" rule. Since the elements are numerous, and the interactions between them equally so, the system establishes its trajectory on the basis of the most widespread "compatibility agreements", which reflect the degree of homogeneity within the system (or the degree of permeation within a network). This theoretical choice makes it possible to minimise the deterministic effect of the systemic principle. The "majority interactions" organisational principle can be investigated in terms of a process of concretisation: appropriate action taken by a system operating within a framework of constraints.

And yet one is entitled to feel a certain degree of frustration with the notion of developing a national innovation systems approach while paying so little attention to the system's social environment. Whether at the level of the firm, the industry or the nation state, it would seem that the social aspect of the concretisation of the system does not enjoy the same degree of precision as the technological and strategic aspects. If innovation is the result of a transition, whether incremental or more radical, the new relations between the actors must be perceived at all levels. Can the innovation be observed in new organisational structures, in new relations between occupations and professions, and to what degree are they affected? Is the innovation reflected in new networks of institutional relations?

Nevertheless, it would seem that, at the level of the firm, such elucidation does take place, since innovation exists only through the transformation of relations and compromises between actors (Hatchuel, Moisdon, Weil, 2001). A very clear distinction is made here between invention and innovation. Full account is also taken of the materiality of an economic activity (Callon 1986; 1989). The analysis strikes a judicious balance between organisation and institution. A method is defined for plotting the actors' relationship to the institution, to its myths even, by revealing the feedback effects on collective action. The

constant nature of the "actor - organisation - institution" relationship fortunately serves to temper the more rhetorical approaches that seek to forge logical investigative frameworks.

According to these studies, there can be no innovation without compromise. However, the compromises are reached not so much between individuals as between different forms of knowledge. Technical innovation is also social innovation and, above all, a reorganisation of knowledge within the organisation. This realisation raises some formidable questions about dynamics: if innovation side-lines certain forms of knowledge in favour of others, how can the technological potential be made durable in the longer term? If an organisation decides in favour of knowledge selection, how can knowledge be capitalised? This gives rise to the more emblematic question of the relationship of the institution (forms of knowledge) to the organisation (the compromises between the forms of knowledge held and used by the actors). This question opens up a sphere of investigation that is interesting, since the links between innovation, organisation and institution are very dense here.

Viewed as an outcome, finally, innovation represents a very particular form of outcome, since it is a precursor of a new dynamic.

I-4. Innovation as process

Innovation can be seen in tangible outcomes. It can also be seen in the transformation of an organisation's capabilities over time (Nelson & Winter, 1982). These capacities affect the interpretation of the system of constraints, the technological potential held in store and the understanding of possible strategies. In other words, the factors involved in innovation are not all located within the firm. The firm merely compiles resources on the basis of collective action plans by attempting to make the best possible use of these factors (Dosi, 1988).

1-5. Innovation within the firm, or how to harmonise differing rates of evolution

The literature survey reveals a high degree of polarisation around the notions of competence and institution as means of giving an account of innovation. The same analysis also highlights the vagueness, the uncertainty even of the boundaries of the firm (it seems essential now to conduct an investigation into the hybrid nature of economic structures, practices and mechanisms). The significance of both of these findings is that they place at the centre of the analysis the capacity to create new activities, whose dynamic is located within processes shared between actors and between factors that are internal (firm) and external (knowledge and learning produced by organisations and institutions). From this point of view, the notion of competence cannot stand in contrast to skill and occupation, since it denotes the ability of an actor to take part in a shared process. For all that, there is no specific competence for innovation. On the other hand, there are competences for analysing market opportunities and the forces of competition and for assembling and regulating technologies and occupations.

Nevertheless, the linkage between occupations and skills within a competence

(generic or otherwise) developed at firm level still has to be defined more precisely. As currently defined, the management of individual competences represents a desire to establish an interplay between economic activity and the allocation of human resources. In so doing, it exposes itself to the same problems as the dynamic of forms of knowledge. How can a firm's competence be defined? What principle of aggregation or disaggregation can be used to do so? What is/are the relation(s) between the organisational (management of competences) and the institutional (production of competences)?

Thus, one is entitled to ask whether the link between firm-level competence and the individual competences forged by the education system has any validity. This survey shows that it does, provided that the innovation process is regarded as a process whose aim it is to articulate (or harmonise) differing rates of evolution in a number of different spheres (social, technological, strategic, organisational, and institutional). Hence the relevance of the distinction made between the various actors. Firms are responsible for developments only in the strategic sphere, where their decisions (i.e. the strategies they adopt) are intended to harmonise developments in the four others (i.e. to integrate differing rates of evolution).

Of course, this meaning of innovation is all the more valid the closer the degree of change involved is to the radical than to the incremental end of the spectrum. This does not mean that incremental innovations have no significance other than a strategic one, since even a sequence of incremental innovations usually involves organisational conditions, relations to knowledge and a social equilibrium that have to be coordinated with each other.

I-6. The factors of innovation

The various evolutionary processes that contribute to innovation have their own determinants (Schumpeter, 1939). If they are to produce innovation, they have to be not only harmonised but regulated. The act of regulation is performed by each of the actors operating in its own space. As far as the firm is concerned, the aim here is to intervene in the evolutionary processes developing in collective spaces (scientific and technical policy, technological standards, production of formal qualifications, etc.). This very collectiveness inevitably gives rise to tensions that help to produce change. The firm then acts in such a way as to derive as much benefit as possible from the evolutionary processes by bringing into play regulatory mechanisms (that are of necessity joint) within and between the various spaces.

Technological evolution: the result of the interplay between firms' technological strategies and international scientific and technical paradigms.

Organisational evolution: the result of the interplay between the internal actors and the web of constraints imposed by market structures.

Social evolution: represents the interplay between changes in the relations between the various occupational categories and statuses and changes in external labour markets.

Institutional evolution: the result of actions that tend to reduce the uncertainties in the framework of collective action. The aim is to stabilise rules and reference models after having tested coordinating mechanisms.

The last two evolutionary processes are the ones that have the strongest societal component. The act of regulation consists of integrating the constraints arising out of each of the evolutionary processes into the definition of a plausible collective action, the effectiveness of which will depend on a good understanding of the interactions between different evolutionary processes. This understanding is reflected in particular in the ability to decontextualize events in each of the processes and to appropriate them in order to incorporate them as effectively as possible into the collective capabilities that pave the way for innovation.

The difficulty in such an exercise lies in the articulation of evolutionary processes that remain separate. Hence the predominantly exploratory and experimental nature of the exercise (March, 1999).

It is at this level that we must seek to identify the procedures that firms put in place in order to engage with these various processes. What are the demands emanating from each of the spaces (social, organisational, technological and institutional)? How are the links between them established? What are the stages in the process leading to innovation?

Within the research object "innovation process", it is the term "process" that provides the best starting point for investigation. While the outcome of this process cannot be known in advance, there can be no doubt that firms feel themselves obliged to develop their creative capacities. This in turn places the regulation of the rates at which the various factors of innovation evolve at the centre of the analysis. How do firms develop their conscious experience in this area? To what extent are firms capable of learning from their own actions? What are the paths taken by learning organisations? At what levels do firms learn best (social, organisational, technological and institutional)?

How do firms construct their environments: choice of external allies and intermediate actors? In what ways do firms exert influence over institutions? What is the role of "intrapreneurs"(intermediate actors within the firm)? How does innovation fit into firms' (hierarchical) social system? What typology of actors involved in innovation can be drawn up as a result?

Do firms take into consideration the shifting and fixed constraints on the innovation process?

II - KNOWLEDGE, COMPETENCE, CAPACITY AND LEARNING

Terms such as knowledge, know-how, competence, capability and learning abound in the innovation literature, without any clear definition of their content, the level at which they are located or the relationships between them. However, they do emerge as basic connective notions that provide a substantial definition of the multiple dimensions of innovation. At the end of a survey that has stressed their importance, we will attempt to clarify them, albeit at the cost of a certain

degree of simplification.

II-1. Knowledge

Knowledge is learning acquired during a period of more or less deliberate research activity and accepted and legitimated by a community of peers organised for that purpose. Objectified in this way, it in turn becomes an object for individuals. It can then be appropriated by individuals and become an essential component in their performance, as human capital or an element in their particular aptitudes. As a good (or object), it can be subjected to specific analysis. However, depending on the forms it takes (i.e. its characteristics), it can be manipulated, more or less effectively, by individuals.

The characteristics of knowledge as an object depend on the opportunities individuals enjoy for gaining access to it. It will be codified knowledge when it is in a format that makes it directly accessible to individuals who have already acquired a body of knowledge in the same field. In this case, appropriation will be a largely cumulative process. The codification of new knowledge involves the shaping of its content as much as of its container. It thus constitutes a stage in the transformation of this knowledge into information, i.e. into a "message that can be easily communicated among decision agents" (Dasgupta & David, 1994).

This characterisation of knowledge as a good (information) actually poses a problem of communication. This communicational dimension means that the knowledge, even if codified, has first to be decoded by the user before it can be acquired; moreover, it places knowledge in the critical category when it comes to transmission (problem of meaning). It is indeed the case that knowledge is not always "tractable" or communication always perfect. Some economists (Polanyi 1962; 1969) gave prominence at a very early stage to the tacit dimension that is coextensive with knowledge, i.e. the implicit reference in the acquisition of knowledge to the objects surrounding communication. More recently, Lundvall has reformulated this question by drawing up a typology of four types of knowledge: know-what; know-why; know-how; know-who. The first two have certain similarities with codified knowledge, while the last two equate to the tacit knowledge that is acquired principally through the interaction between actors. In fact, three types of approach can be discerned, depending on the way in which this tacit dimension of knowledge is dealt with.

II-2. Knowledge and information

The first approach is adopted by the most orthodox economists, who continue to treat knowledge as mere information (Aoki 1986). Their favoured object is the analysis of patents, as the prototype of the formalised knowledge that is exchanged in the market. The transformation of tacit knowledge into codified knowledge and the disclosure of knowledge depend above all on decisions taken by individuals. Such decisions involve effort on the part of the individual who, in return, might derive some benefit from them. That being the case, this process of transformation/disclosure might be the result of economic calculation. This possibility ensues from what Dasgupta and David (1999) call the "endogeneity of tacitness". In certain

cases, however, this process of codification proves to be extremely costly, or even impossible because of difficulties inherent in the particular form of knowledge under consideration (.

The second approach, in which knowledge is not reducible to information, consists of interpreting the transmission of the knowledge in terms of "translation", an important preliminary exercise for decoding proper (Callon 1999). The transposition of knowledge into a context other than the original one requires two successive processes: a preliminary decontextualization and a subsequent recontextualization. Each of these operations is performed by means of "translations" in which, often with the aid of materials such as documents, formulas, prototypes etc., an item of information is extracted from one cognitive structure and inserted into a new one. Thus, this cognitive process involves the constitution of the "socio-technical networks" through which knowledge circulates.

The third approach has its roots in institutionalist schools of thought that give prominence to the process of knowledge creation embedded in the routines of economic activities. In this case, knowledge is considered in the context of the institutional arrangements within which it is contained. Since it is shaped by a set of shared habits, routines, established practices and representations, knowledge is considered as being more or less local or idiosyncratic in nature. For this reason, the circulation of knowledge requires individuals to be in reasonably close proximity to each other and to have shared norms, conventions and, more generally, representations. Some authors speak of the "social shaping of knowledge" (Hage & Hollingworth, 1996) or even of the "institutional nature of knowledge" (Foray, 2000). The notion of "national system of innovation" is based on such a concept of knowledge (Freeman, 1987; Lundvall 1988; 1992; Nelson, 1993).

Although our own approach, which draws its inspiration from societal analysis (Maurice, Sellier, Silvestre 1986), is close to this last approach, we do not for all that exclude the two others, which link the creation, transmission and utilisation of knowledge to the market mechanism, on the one hand, and to the networking mechanism, on the other. Both of these mechanisms have to be regarded as included in the range of institutional arrangements (Nohara, 2017).

The originality of our approach is that it puts forward an interpretation based on the construction of the actor: the creation of knowledge is as much the outcome of the investment or the translation as of the construction, through socialisation and learning, of the actor in whom the knowledge is embodied.

II-3. Individual and organisational learning processes

For individual and collective actors, knowledge is a raw material to be shaped, transformed and transmitted. The firm can even be seen as an organisation in which knowledge (input) is transformed into an output. However, the nature of knowledge is such that the firm can no longer be considered as a simple mechanism for allocating factors of production on the basis

of price. The production function here is based essentially on cognitive activities and interactions between actors. In consequence, it is necessary to investigate the way in which the capacities of individuals and the competences of firms are constructed, from both the social and organisational point of view. Innovation is increasingly a process in which new knowledge is accumulated and combined. In consequence, it is the learning capacities of individuals and of collective entities, particularly firms, which are the principal determinant of productive efficiency and the fundamental economic issue.

Very generally, learning can be defined as a process leading to the acquisition of knowledge or competences and to an improved ability to act effectively, or even as a process of error detection and correction. It is increasingly linked to innovation and, in a situation of uncertainty, is firmly oriented towards problem definition and resolution. In this sense, uncertainty is both a constraint and the major source of new knowledge.

The learning process of course has a dual dimension, having both individual and organisational aspects. Although it has to be acknowledged that the act of learning is a fundamentally individual one (only human beings can learn), learning nevertheless involves capabilities that are more organisational than individual. The predominance of organisational capabilities can be explained by the fact that the construction of individual knowledge and know-how depends, firstly, on the societal context (in particular the education system) and, secondly, on the way in which they are integrated into particular organisational settings. Indeed, organisations play a major part in this process of individual learning, by placing individuals within an incentive structure and giving them a common framework (a model of behaviour, cognitive maps, company culture, etc.) with which their actions interfere in order to create new, shared knowledge. The learning process proves to be eminently interactive and cognitive. Thus, this cognitive process is very closely linked to the social construction of the actors. In consequence, it must be examined as a social and collective phenomenon that is reproduced through the management hierarchy, control mechanisms, incentives, mobility, the division of labour, cooperation, teamwork, etc.

From the perspective of what has just been said, organisational learning is defined as a collective phenomenon involving the development of new competences and the acquisition of shared knowledge. Organisational learning takes place as soon as the acquisition of strictly individual knowledge modifies the collective rules governing behaviour (or routines) and the performance of the entity. In other words, the development (or implementation) of a new competence within an organisation involves several members of the organisation and is likely to alter the organisation's capacity to deal with certain problems. Thus, learning involves the discovery and adaptation of new problem-solving procedures. From this perspective, the organisation can be interpreted "as a mechanism for converting individual into collective learning (and consequently for converting collective into individual learning)".

II-4. The capabilities or competence of the firm in respect of innovation

In the same way, the notion of capability contains within it two interacting dimensions, the individual and the organisational. On the individual level, it is linked to the notion of skill. On the collective level, a connection is made between capability and competence, which is understood as a fund of organisational knowledge, memories and routines of which the firm is the repository. Because of its multiple meanings, we will limit use of the term competence to the firm.

Individual capability is based on skill. This in turn is constituted by the totality of knowledge and know-how embodied in the individual and that he or she can mobilise in concrete problem-solving situations. As human capital, it is the object of investment and is more or less "portable" between different places or organisations. Once again, however, the phenomenon of "social embeddedness" (Granovetter, 1989) should not be ignored; in other words, individual capability is embedded in societal and organisational contexts that delimit the space within which the individual attributes a particular meaning to his calculation of the economic value of his human capital.

The capability of a firm is not simply the sum of the individual capabilities that constitute it, even if it is founded on the know-how of each individual worker. In essence, a firm's basic attribute is made up of a set of competences accumulated in the course of its past trajectory and serving as reference points for its future actions. By virtue of their idiosyncrasy derived from the firm's own history, these competences enable it to maintain a competitive advantage and to exist as the organiser of mechanisms put in place in order to furnish the market with a supply of goods or services. Thus, these competences generate two categories of capabilities, one of which comprises the coordinating capability governing relations within the firm and the other the capacity to manage its relations with its environment.

II-5. Routines and coordination

The firm, with its division into functions or tasks, needs internal coordinating mechanisms in order to maintain its coherence. As authors of the evolutionary school (Nelson & Winter 1982) have noted, it functions by laying down "routines" that act as reference points for action. By virtue of their automatic and regular nature, these routines facilitate the accumulation within the organisation of partially tacit and specific technological knowledge. However, they also allow decisions to be taken quickly and make it possible to anticipate the activities of others and to establish rules of coordination. It is the complexity of tasks (and of the division of tasks) that encourages routinisation and the development of norms and socially constructed responses in the form of rules. These routines are of course an essential factor in the coordination of the various members of the firm, and hence in its performance. Thus, the main challenge for the firm in this respect is to select effective routines and to diffuse them. Furthermore, it is inherent in the nature of routines that they are resistant to change. The complexity of the task of coordination tends to favour the preservation of existing procedures in order

to maintain coherence by means of control mechanisms. Once developed, they tend to be incorporated into routines. At the same time, and very paradoxically, firms need to modify their routines as markets and technologies evolve. Since the competitive environment is constantly changing, firms are constantly being forced to develop more effective routines in order to retain their competitive advantage. They constantly have to innovate or reinvent the rules by which they function in order that they more closely match the new situation, i.e. they have "to learn how to learn".

This notion of coordinating capability appears to be shot through with a permanent tension between, on the one hand, the preservation of routines that construct, order and maintain knowledge and know-how as a coherent whole and, on the other, the search for new routines that might produce renewal. In other words, firms are not only structures for the management and accumulation of specific knowledge but also entities endowed with rules governing their functioning that embody the collective lessons learnt in the course of their history and with rules governing their development, through which new knowledge can be acquired.

II-6. Control of the environment and organisational capabilities

The ability to control its own environment is a relational competence that a firm develops in relation to/or with others. It is surrounded by competitors in the product market, by suppliers of intermediate products and services in the production chain, by subcontractors in the social division of labour, by educational establishments as purveyors of human resources and even by research institutes as suppliers of knowledge. The firm is located within a configuration of actors that it helps simultaneously to forge. Not only does it have kept a close watch on changes in its environment in order to identify, grasp and exploit new opportunities as they present themselves, but it also has to develop the ability to listen (marketing), to develop interfaces (user-producer relationship) and to cooperate (partnership). This interdependence between the firm and its environment is rich in potential, provided the firm is able sufficiently to endogenize its environment within its own structures in order truly to appropriate the resources it offers. Beyond the market, it is only the collective and social construction of these links between the internal and the external that enables the firm to develop its ability to absorb and appropriate technological knowledge and know-how and to exploit outside resources.

Although they are the object of inherently different learning processes, these two types of internal and external capabilities are very closely linked and interlock with each other to form the firm's "organisational capabilities", which are the real engine of innovation.

III - THE NOTIONS OF ACTORS, ORGANISATIONS AND INSTITUTIONS WITHIN THE FRAMEWORK OF AN "INNOVATION SPACE"

Our "societal approach" places the construction of the actors in the innovation process at the heart of its analysis, which sets it apart from standard economic approaches in which the process is perceived essentially in terms of investment, diffusion of information

and knowledge, increase in productivity, allocation of capital, etc. In a complex field in which a multiplicity of actors operates, an approach of this kind seems to be essential if any progress is to be made in understanding the intensity and quality of the relationships between innovation and higher education at the micro-economic as well as the societal level (Sorge, 2005).

III-1. Actors and spaces

In this approach, the processes of socialisation, mobility and organisation play their part in the simultaneous constitution of the actors and their common socio-occupational identity and of the space in which they operate. The actors are not simply individuals acting and drawing up behavioural rules independently of what creates group membership; rather, they are an "individual or collective entity with a capacity for socialisation and structuration" (Maurice 1986). For its part, the notion of space defines "the sphere in which the socialisation of the actors and the structuring of their exchanges and social relations develop". This explains why actors and spaces interact with each other, contributing in the process to each other's construction.

Thus, the engineer category, which plays a central part in firm-level innovation processes, formed itself into a collective actor not only through the relations with the higher education space developed during training but also through the acquisition over the working life of a professionality developed on the basis of contacts forged with the scientific and technical research space and through its location within the firm-level innovation space. Therefore, the various qualities of this particular actor help to define the "spaces" with which it interacts. In this approach, actors and spaces are formed within the framework of their own social trajectories and occupational pathways. In consequence, longitudinal analysis is one of the main planks of the corresponding methodology.

Any attempt to investigate the relations between the firm-level innovation space and higher education systems requires the development of varied and complex investigative tools. The notion of actor can be applied both to collective actors and to individual actors. It also makes it possible to apprehend the influence within the innovation space of certain small groups of individuals or even of isolated individuals. The innovation space must be investigated at various levels - macro, meso and micro-economic; at the macro level, it has similarities with the notion of national innovation system, which is produced by the interdependencies between the actors in the spaces that contribute to innovation: R&D, education, industry and market.

In an approach that gives prominence to actors and places the firm at the heart of the innovation process, it is necessary to view organisations and institutions as "social constructs" and on that basis to make a distinction between the actor-organisation, in the sense attributed to it in organisation theory, and the actor-institution.

As is suggested in institutional economics, one of the specific characteristics of institutional actors is that they initiate norms, rules and conventions. And as certain sociologists assume, they also constitute action systems that have both a utilitarian and symbolic function. In this sense, they

embody a certain inertia and contribute to the establishment of routines within processes. The degree to which they are formalised is, therefore, variable. However, since they are also engaged in a permanent process of development and legitimation, they constitute a process of socialisation "through which the social relations between actors take on substance and meaning". And just as these institutional actors emerge by socialising themselves, by being legitimated by the other actors with whom they interact, so they can disappear if those conditions are no longer met. Each institutional actor mediates between the other actors and the wider society. The various arrangements formed by each of them help, at both the micro and national levels, to specify both the various innovation spaces at firm level and national innovation systems.

Like research institutes and higher education establishments, firms are both productive organisations and institutions that help to construct the innovation space at firm level. However, we will give differing degrees of prominence to the specific roles played by these entities. Thus, the firm as organisation will be given greater prominence than the firm as institution, since it is a better starting point for investigation of the way in which the firm constructs its professionality and collective skill with respect to the various spaces with which it interacts. In contrast, higher education establishments and cooperation between two research institutes, one public, one private, will be examined rather as institutions. They will be approached as mediators between the actors and society, as "ferrymen" between the micro and macro levels.

Apart from various collective actors, such as the occupational categories of engineers and researchers, and the institutions and organisations that together constitute the force driving the industrial dynamic, we must have the option of giving consideration to other, less visible and less easily identifiable actors, such as maintenance and sales engineers, for example, whose activities are indispensable to the innovation process.

It must also take into account certain individuals whose role as actors is fundamental. Their personal trajectories need to be investigated because of their effect on the innovation process. Thus, the careers of some company directors and founders, particularly in SMEs, influence the professionality of their organisations and the innovation space as a whole.

III-2. The construction of the actors and the innovation space: an interdependent process

The innovation space is a social construct created by the interdependencies between various individual and collective actors, institutions and organisations belonging to the various spaces that contribute to innovation processes (scientific space, educational (and knowledge generation) space, industrial space). The innovation space at firm level is constructed from a set of interdependent relationships that the firm helps to shape but that also encompass it. It develops both within the firm and in the wider society. Thus, this notion of innovation space is a means of integrating the multiple levels of observation and analysis.

The diagram below is an attempt to depict

the totality of these interdependencies between spaces and actors at firm level, local and sectoral level and at the level of society as a whole. It has its roots in societal analysis and seeks to give prominence to the intermediate level between the firm and the wider society that has hitherto been little understood as well as to the role of institutions, which is simultaneously stabilising and dynamizing, and the mediating function they fulfil. It is intended to serve as a framework of analysis for the sectoral and regional studies as well as for the case studies of firms.

Placing the actors at the centre of the innovation process makes it necessary first to identify them in all their diversity and to observe the interactions they enter into with other actors and within different spaces. This raises the question of whether some actors are more essential to the process than others and whether their greater importance helps to structure the innovation space itself.

Moreover, the same institutional actor, for example, can play a different role at firm, sector and national level. We need to have at our disposal the instruments required to follow the actors as they move not only between the different spaces but also in time and space.

IV – CONCLUING REMARKS

We will finish our literature survey by proposing four remarks which could contribute to the future development:

1. The societal foundations of innovation

The notions of "national innovation systems" and "firm-level innovation space" referred to in the course of our text carry with them the strong implication that firms' capacity to innovate is structured by their relation to society and is specific to the country in question. It is the outcome of various mediations constructed at national level. Among these various processes of mediation, higher education is assumed to play a fundamental role. If this is indeed the case, then it is necessary to ascertain in what respects national higher education systems are indeed important resources for the construction of firms' innovative capabilities and how these resources are constructed and mobilised.

Against the background of the internationalisation of R&D activities, this kind of approach to research explains why increasing attention is being paid to the ability of international firms to monitor and assimilate the competences and knowledge produced in the various countries in which they operate.

Nevertheless, to judge from the findings of some research projects (albeit not very recent ones)[1], "national technological systems" have remained relatively autonomous.

Between 1981 and 1986, the basic research carried out in a given country continued to feed into a technological system largely

[1].We are referring here principally to the research carried out by Patel and Pavitt (1991) on patenting inside a country by firms foreign to that country. The main finding shows that large firms still play a relatively small part in national technological activities; only in Belgium, Canada and the UK do they account for more than 15% of the total. Patent applications lodged in the USA by American firms in respect of activities carried out in France, Germany, Japan and the UK account for the following shares of all patenting in the country: 2.4; 6.9; 3.2; 16.7. However, these data relate to the period 1981-1986.

under the control of national firms. In most countries, the links with foreign research and higher education systems established through personal contacts and recruitment remain relatively modest compared with national links (Lundvall, 2002).

Nevertheless, it cannot be deduced from this analysis that firms have continued to behave in similar ways over the last decade. Indeed, in a context in which firms' capacity for innovation is becoming a crucial criterion in their international competitiveness, the development of R&D units in different countries makes it easier for firm to exploit the research carried out in universities in those countries, by establishing local contacts, setting up local joint ventures and recruiting scientists and engineers with research experience acquired in the national and local higher education systems.

The question that then arises relates less to the extent to which science and higher education resources are becoming internationalised than to the way in which international firms can combine and coordinate these "societally" constructed resources within their own specific innovation processes (Nohara, 2006).

In order to make progress along this particular route, consideration must be given to at least two categories of analytical levels: the sectoral level and the local, national and global "geographical" levels.

2. Technological innovation as a process that varies over time and from sector to sector

This hypothesis has been illustrated by the notion of technological paradigm and trajectory developed by Dosi (1986). The technological paradigm (like a scientific paradigm as defined by Khun by determining the fields of investigation, the problems, the procedures and the tasks to be carried out) helps, through a process of selection, to fit new technological discoveries into a trajectory of possible solutions and competences that draw on research and experimental work inherited from earlier phases ("path dependency"). The corresponding technologies and scientific disciplines have deep sectoral roots, which helps to give them economic significance (Edquist, 1992). Such a concept of technological innovation provides a framework for analysing the "firm-level innovation space", on the basis of studies carried out at LEST (Lanciano-Morandat, Maurice, Nohara, Silvestre, 1998).

Indeed, our understanding of the construction of firms' innovative capabilities, using this meaning of space as an analytical tool, can be improved by using the notion of technological and scientific paradigm to focus more closely on the construction process. This approach is all the more justified since the main focal point of the project is the relationships between industrial R&D, university education and academic research. It would seem to be particularly relevant as a means of apprehending how researchers and engineers are positioned in the firm-level innovation space relative to some of the dominant scientific and technological paradigms (or reference systems) that are more highly developed in such and such a sector.

Furthermore, it is necessary to establish connections between the approach based on the "firm-level innovation space" and the

hypothesis that scientific and technological paradigms exist. Such paradigms provide an interpretative framework for analysis (notably from a comparative perspective) of the work and organisational practices of researchers and engineers in a given firm or in a given sector in a particular society. They structure R&D practices, orienting them towards the generation of incremental innovation as a means of competing with at least partially identified products or technologies. Their emergence may also be linked to strategies based on radical innovation and competitiveness regardless of cost.

Thus, it is desirable to know, for example, in what respect and why researchers and engineers are "followers"(to use Porter's expression) and in what respect and why they are "innovators" relative to the dominant mode of posing problems and working in a particular area of research. Such a question suggests it might be necessary to go beyond the rather too general notion of paradigm in order to identify the precise objects and direction of research investment (tangible and intangible) and to discover who makes the crucial decisions in this area by taking into consideration the societally constructed framework within which collaborations with universities and scientific research bodies take place. Finally, what resources are mobilised, through what mode of organisation (in terms of specialisation and division of labour), what institutions (or institutional forms: mixed research establishments, joint ventures…) and what networks, in order to realise the scientific and technological objectives and plans drawn up by firms? Such approaches to research will enable us to gain a better understanding of how scientific and technological paradigms develop at the international level, since such paradigms are always given a particular societal "spin" which maintains the diversity and therefore the mobility, one might even say, the "engine" of ideas and creations in the sphere of science and technology.

3. The construction of the innovation space: between globalisation effects and local dynamics

The relations between science, technology and industry will benefit from consideration of the notion of "territorial proximity constraint"(Porter, 1990), and the conditions under which it is being moderated as a result of the "globalisation" of science. Some economists have demonstrated the extent to which the results of basic research cannot be regarded as a "free good", i.e. a good that firms can access without cost[2], because of the level of knowledge and competences required to access this scientific output in its various forms. One of the important functions of university research is to train skilled researchers who will then embark on careers in basic or applied research, taking with them not only the knowledge produced by their research but also competences, methods, techniques and a network of professional contacts. As a result, "cognitive constraints" become "proximity constraints", which may take various forms, particularly organisational

[2]I.e. without incurring expenses or making investments, particularly in human resources, since tacit knowledge is embodied in individual workers.

and geographical ones.

The combination of these two types of proximity gives rise to what some economists have suggested should be called "territorial proximity" and which could be an element in the firm-level innovation space. In a research project on the nature of the relations between university research and industrial R&D, therefore, it would be pertinent to have information on the nature (particularly the skills), origin (institutional: university, public laboratory, engineering schools in the case of France) and organisational level (local, regional, national, international) of the human resources deployed in the firm-level innovation space in order better to identify the various components of these spaces from an international comparative perspective (Lanciano-Morandat, Nohara, Verdier, 2006).

Such a perspective also suggests it would be worthwhile clarifying the organisational and contractual forms in which these human resources are deployed (do they belong to the firm or to a research unit run jointly with a research organisation? What types of employment contract are used and what forms of incentive are associated with them?).

Finally, since firms themselves play a part in the construction of their own internal labour market for scientists, engineers and technicians, it would also be helpful to identify the local, national and international infrastructures they can access for the continuing training of their human resources and to clarify the nature of those infrastructures and the particular mix available to individual firms. Are they integral parts of the firm in question or are they constituted by a range of different institutional actors (universities, local/regional authorities, European Community) cooperating with each other or financing the training of human resources in the firm-level innovation space?

Concurrent with the investigations that have been conducted into the notion of "territorial proximity" and its role in the process of technological innovation, two arguments have tended to lessen the importance of the "territorial proximity" constraint for technological innovation. The first relates to the use of information and communications technologies and the second to the international mobility of researchers and engineers. The first raises the question of the accessibility of these technologies from within the firm-level innovation space and the concomitant problem of the exploitation of the information gathered and the efficient use of computerised means of communication. Given that the use of new information and communications technologies is very highly developed in both basic research and R&D, it might reasonably be asked whether there is still a degree of compartmentalisation (which would vary depending on the innovation space in question) between basic research and industrial R&D and, by way of corollary, who the actors are that are driving the decompartmentalization. For example, what role is being played by young engineers and researchers coming out of basic research or the engineering schools who have acquired the knowledge and competences required to use the databases and global scientific networks in their particular spheres of expertise? And what means are firms using to mobilise these competences effectively and in accordance with their own animating principles?

Above all, it will be important to specify the forces that are contributing to the growing interdependence of national systems and possibly also to a shift in the levels and spaces in which coherence in matters of innovation is produced.

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