Territorial innovation dynamics: a knowledge based perspective

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TERRITORIAL INNOVATION DYNAMICS:
A KNOWLEDGE BASED PERSPECTIVE
A CROSS-ANALYSIS OF THE I-SPACE MODEL AND THE ARCHITECTURAL KNOWLEDGE CONCEPT

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Abstract

Many studies have focused on the role played by geographical location in the emergence and building of localised learning capacities (Maskell and Malmberg, 1999). In this perspective, empirical studies have demonstrated that the innovation dynamics of clusters result from the quality of interactions and coordination inside the cluster as well as interactions with external, often global, networks. In this context, knowledge exchange between firms and institutions are claimed to be the main drivers of spatial agglomeration (Canals et al., 2008). Hence, cluster policies have followed the main idea that geographic proximity facilitates collective innovation in that firms can capture knowledge externalities more easily. This idea is in fact very attractive but contains some limitations (Suire and Vicente, 2007): if some clusters are successful, others seem to decline. Therefore, in order to understand the territorial dynamics of clusters, the analysis of the specific nature of knowledge and information flows within a cluster is crucial.

The objective of this paper is to enhance the analysis of the role of cognitive and relational dimensions of interactions in territorial dynamics of innovation. We focus on the key sub-process of innovation: knowledge creation, which is above all a social process based on two key complex social mechanisms: the exchange and the combination of knowledge (Nahapiet and Goshal, 1996). We suggest building a theoretical framework that hinges on these two key mechanisms. In this line, we apply Boisot's I-Space model (Boisot, 1998) for the diffusion and exchange of knowledge and suggest completing the model by introducing the concept of architectural knowledge (Henderson and Clark, 1990) so as to take into consideration the complexity of the combination process. This analysis is conducted through the illustrative analysis of three different case studies. We will draw upon the case of Aerospace Valley Pole of Competitiveness (PoC), the Secured Communicating Solutions PoC, and the Fabelor Competence Cluster. The cases show that the existence of architectural knowledge is pivotal to territorial innovation.

Keywords: architectural knowledge, I-Space model, territorial innovation, geographical clusters

Introduction

Many studies have focused on the role played by geographical location in the emergence and building of localised learning capacities (Maskell and Malmberg, 1999). In particular, one crucial phenomenon has been pointed out: usually globalisation implies the harmonisation of international markets, the reduction of transport costs, as well as a relatively even spread of similar companies around the world (Steinle and Schiele, 2002). But paradoxically, in the globalisation context, some regions within nations are becoming central in terms of industrial innovation, bringing renewed importance to the immediate environment in which companies are located (Porter, 1998; Asheim and Gertler, 2005), and to the *territorialisation* of activities (Longhi, 2005). The recent implementation of the French Pole of Competitiveness (PoC, or *Pôles de compétitivité*) policy, has been developed precisely in this perspective. The Pole of Competitiveness, and cluster policies in general, are indeed the main current model fostered by the European Union for the development of sectoral economies. European countries are therefore attempting to structure their local economies based on cluster strategy.

The main idea of cluster policies is very simple: geographic proximity facilitates collective innovation in that firms can capture knowledge externalities more easily. Indeed, some sorts of knowledge are still sensitive to face-to-face interactions, particularly when tacit knowledge is involved. In this context, it is claimed that geographical proximity improves knowledge diffusion and enhances collective innovation. This idea is very attractive but contains some limitations (Suire and Vicente, 2007). Empirically, if some clusters are successful, others seem to decline. The theoretical definition of knowledge externalities often remains a black box. In order to understand the territorial dynamics of clusters, it is therefore crucial to analyse the nature of knowledge and information flows, and all the more so as knowledge exchange between firms and institutions is the main driver of spatial agglomeration. Consequently, the way knowledge is managed, structured, diffused and with what degree of formality (Canals, Boisot and MacMillan, 2008) plays a key role in our analysis of territorial cluster dynamics.

The purpose of this paper is to enhance the analysis of the interactions that support territorial innovation dynamics by focusing on the relational and cognitive dimensions of these interactions. To this end, we apply Boisot's Information-Space (I-Space) analytical framework (1997, 1998). In the I-Space model, Boisot proposes a dynamic analysis of exchanged knowledge and information. The application of the framework aims both at characterising the nature of the knowledge exchanged (concrete – not codified/abstract – codified) and the governance features that influence the knowledge exchange in a given territory. Notwithstanding, analysing knowledge only through the tacit-codified lens is insufficient. The reality is more complex as attested by the example of the management of scientific codified knowledge in which the processes of production and translation involve a great deal of tacit knowledge (Heyraud, 2003). For this reason, in this paper we suggest expanding the analysis of knowledge by distinguishing two types of knowledge: technological knowledge and architectural knowledge.

The main contribution of the paper is to improve the comprehension of cognitive and relational interactions on territorial knowledge creation dynamics through the illustrative analysis of three different case studies. We will draw upon the case of the Aerospace Valley PoC, the Secured Communicating Solutions PoC, and the Fabelor Competence Cluster.

To begin, we provide a brief literature review (section 1), present the theoretical framework (section 2) and introduce our methodology (section 3). Subsequent sections report the results in each cluster: the Aerospace Valley PoC, The Secured Communicating Solutions PoC – subdivided in two cluster studies –, and the Fabelor Competence Cluster. For each cluster we provide a brief historical background and analyse the nature of transactions and knowledge flows. The discussion and implications in terms of challenges and possibilities for future research conclude this paper.

Literature review

It has been convincingly documented that in our knowledge-based economy, innovation and knowledge creation have become fundamental for the sustainability of economic processes (Solvell and Zander, 1998; Spender, 1996), and that the returns of agglomeration economies or location are of strategic importance (Feldman and Martin, 2005). Clusters, or local systems, have increasingly focused attention and triggered a large strand of literature. In the present section we summarise the main stages in the development of this literature, and underline the main remaining issues at stake. In fact, the highly intensive competition between companies and the extremely fast pace of technological change increase the need for companies to innovate. To achieve this, companies need to manage both their internal resources and their external relationships efficiently, and must also manage increasing specialisation while at the same time exploring new innovation opportunities. Therefore, cooperation in a cluster, where companies can combine their resources and their knowledge assets, is viewed as an efficient means for successful innovation processes (Preissl, 2003). Many studies have underlined the centrality of physical proximity and the benefits of geographical clusters. It is assumed that territories are not interchangeable and therefore the choice of location will be driven by specific advantages in terms of competencies embedded in regions, cities or any local systems.

The advantages of clustering have been abundantly argued both theoretically and empirically since the seminal work of Marshall (1920). Marshall's conceptualisation of industrial districts shows how the benefits of agglomeration come from substituting internal economies with external economies, due to three main types of economic externalities: technological externalities, market input intermediaries and specialised local labour. Agglomeration is basic to economic development, but an important distinction should be made between geographic concentration of production and location of innovation. While knowledge externalities are certainly key in the latter case, the home market effect (Krugman, 1991) and size are more decisive in the former. When externalities arise, they are the result of specific unique capabilities that are built up over time and cannot be transferred or replicated. They form the basis of sustainable advantage for both firms and industries (Feldman and Martin, 2005). However, the organisation of production and the management of knowledge are not independent of the nature of interactions related to the organisation.

Michael Porter initiated the modern age of clusters both in the literature and in public policies. For Porter (2000), clusters are "Geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions in particular fields that compete but also co-operate". His empirical analysis of clusters, however, is mainly restricted to a static analysis of industrial specialisation (Martin and Sunley, 2003). Recent studies on clusters highlight the crucial role of interactions between the actors of the same territory in the development of innovative capacities. They are the cradles of confidence and reciprocity; they favour the reduction of uncertainty and the coordination of actors, and they enhance learning capacities (Camagni and Capello 2000). Therefore, recent lines of thought focusing on clusters tend to focus increasingly on the social dynamics of interactions rather than on traditional key success factors (Bahlmann and Huysman, 2008).

In this perspective, the approach focusing on proximities (Pecqueur and Zimmermann, 2004; Rallet and Torre, 2005) provides an initial valuable contribution to the analysis of interactions. The concept of geographical proximity is used to account for agglomeration externalities and for the question of clustering. Malmberg and Maskell (2005) state that the interactions between localised knowledge foster learning; indeed, some sort of knowledge is still sensitive to face-to-face interactions, particularly when tacit knowledge is involved. Furthermore, some knowledge exchanges are related to cognitive repertories shared by the same community. Boschma (2005) explains that people sharing the same knowledge base (cognitive proximity) may learn from each other: this cognitive proximity is a condition for innovation because it enables collective learning.

Carrincazeaux (2001) has enriched this analysis of the link between geographical proximity and knowledge creation by integrating the notion of "complexity of the knowledge base". This complexity has two different types: combinative complexity when there is a need to map distinct competencies, and technological complexity when new knowledge is required. These two types of complexities generate several possible configurations of proximity relations. In as far as technological complexity is linked to new knowledge created and in perpetual renewal it is assumed to require face-to-face relations, in other words, physical proximity. On the other hand, combinative complexity raises the need for critical interfaces in terms of possible combinations of knowledge; this latter combination would consequently be facilitated when the actors possessing this different but complementary knowledge are co-located.

However, geographical proximity is not sufficient to generate agglomeration economies in terms of knowledge exchange. An "organised proximity" is also needed (Torre, 2006). Organised proximity refers to the capacity of an organisation or an institution to make their members interact. On the one hand, organised capacity relies on the development of a relational proximity, that is to say the sense of belonging developed with the sharing of common identity, values and rules that foster the motivation to exchange and combine knowledge. On the other hand, this organised proximity relies on the emergence and development of a shared repository (cognitive proximity) that improves the capacity to exchange and combine knowledge.

Nevertheless, while organised proximity is important as it creates homogeneity, diversity is indeed the main added-value characteristic of clusters. Current cluster research shows that a territory cannot be simply analysed as a container, but should also be analysed in terms of the intensity of interactions it allows among actors (Markusen, 1996; Garnsey, 1998a; Longhi, 2005; Zimmerman, 2006), highlighting the importance of the systemic aspect of clusters and their patterns of interaction. Contributors to the field have developed convincing empirical accounts in this perspective, identifying the organisational territorial patterns at work in clusters and how they enhance innovation. Markusen's taxonomy (1996, 2000) of the different organisational forms of cluster interactions in the production process, Saxenian's comparison (1994) between Silicon Valley and Boston Route 128, or Garnsey and Longhi's comparison (1998) of the development of two major European high-tech clusters (Cambridge and Sophia-Antipolis), are some convincing examples.

These studies have empirically emphasised that innovations in clusters do not only emerge from geographical proximity: organisational patterns of interactions (Becattini, 1991; Rallet and Torre, 2005) and cognitive proximity (Noteboom, 2002) are essential to their emergence. In this context Giuliani and Bell (2004) focus on intra-cluster knowledge systems, arguing that the link between innovation and geographical clusters can only be understood by identifying the different cognitive roles played by cluster firms (leaders, knowledge gatekeepers, isolated firms etc.). The firms located in the cluster do not have automatic access to local knowledge bases, and experience varying degrees of difficulty in becoming involved in innovative networks. Therefore, the overall cognitive structure of knowledge systems, how they work, and how they evolve over time may clarify cluster success or failure. Thus, geographical, relational, and cognitive proximity provide initial insights into the set up of an analytical framework aiming at analysing the interactions that support the innovation dynamics within a territory.

Location mitigates the inherent uncertainty of innovation. The significance of localised knowledge spillovers as inputs to firms' innovative activities suggests that their most creative and value added activities do not proceed in isolation, but depend on their access to localised accumulation of knowledge (Feldman and Martin, 2005). However, location can be regarded as a necessary condition but not sufficient on its own to access local networks of innovative activities. Access to the knowledge resource base, that is, insertion in local networks of knowledge creation, is not obvious and can vary greatly from one location to another.

Theoretical framework

The objective of the paper is to improve our understanding of the role of cognitive and relational dimensions of interactions in territorial dynamics of knowledge creation, a key sub-process in the process of innovation (Pavitt, 2004). According to Kogut and Zander (1992), Moran and Ghoshal (1996), and Nahapiet and Ghoshal (1998), the creation of organisational knowledge is above all a social process based on two key mechanisms: the *exchange* and the *combination* of knowledge (although these authors admit that other processes may exist, particularly at the individual level). The processes of combination and exchange are complex social processes. They reflect the embedded forms of knowledge within an organisation capable of creating, sharing, coordinating and structuring knowledge. We propose to build a theoretical framework that hinges on these two key mechanisms: exchange and combination mechanisms. To this end, we apply Boisot's framework on the diffusion of knowledge: the Information Space (I-Space) and suggest completing the model by introducing the concept of architectural knowledge (Henderson and Clark, 1990) in order to take the complexity of the combination into consideration.

Boisot's I-Space framework (1999) was created to explore knowledge flows between companies so as to identify the strategies of creation and diffusion of knowledge. As diffusion is a precondition to exchange and combination, the framework focuses on the diffusion of knowledge. The I-Space model starts from the proposition that the more structured the knowledge, the faster, larger and easier the diffusion, by focusing on the link between the nature of knowledge and its capacity of diffusion.

Before presenting the framework, we introduce the key concepts involved.

The structure of knowledge depends on its level of codification and abstraction.

Codification[1] is the process of creating perceptual and conceptual categories in order to facilitate the classification of a phenomenon. If codification lowers the cost of data processing by grouping them, abstraction[2], in turn, reduces the number of categories whose boundaries need to be defined. Abstraction is a form of reductionism, as the process tends to focus on the structure – causal or descriptive – that emphasises the data. Codification and abstraction, working together, have the effect of making knowledge more articulated and easy to manipulate and therefore more shareable (p.51). In other words, abstraction and codification are cognitive processes that favour communication and consequently diffusion of knowledge both within and outside a company.
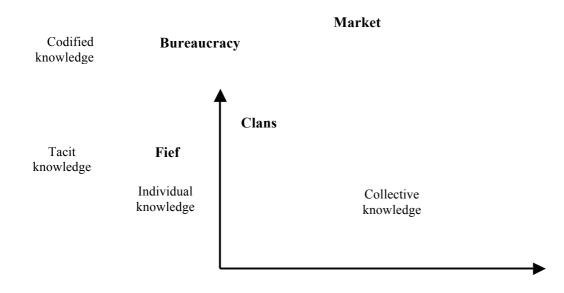
The I-Space model can be briefly described as follows: the graphical representation of the model is structured with three different axes. Each axis characterises the nature of knowledge: axis 1 tacit/codified, axis 2 concrete/abstract, and axis 3 diffused/non-diffused. The author suggests merging axis 1 (tacit/codified) with axis 2 (concrete/abstract) to enable a better understanding of diffusion and exchange of knowledge in the space.

Thus, the I-Space model is built on the above key concepts. In fact, one axis characterises the structure of knowledge, while the other axis presents its level of diffusion. According to the level of structuration and diffusion of knowledge, four modes of governance[3] of knowledge emerge: bureaucracy, market, clan and fief, as presented in the figure below.

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[1] "Codification can usefully be thought of as a process of giving form to phenomena or to experience" (Boisot, 1998, p.41).
[2] "Abstraction is a process of discerning the structures that underlie the forms" (Boisot, 1998, p.41).
[3] Boisot avance que la gouvernance de la connaissance est fonction de la culture, à savoir la structure et le partage des connaissances sociales. Boisot argues that the governance of knowledge depends on the culture, that is the structure and the sharing of social knowledge

Figure 1: I-Space Model (Boisot, 1999)

                                        Market

Codified   **Bureaucracy**
knowledge

                                   Clans

Tacit   **Fief**
knowledge

              Individual   Collective
              knowledge   knowledge

In as far as each knowledge governance structure is linked with specific levels of structuration and diffusion of knowledge, it is possible to apply the model statically, to explain the nature of interactions between actors in both the knowledge creation and the diffusion processes.

The four modes of governance of knowledge are characterised as follows: first, *Bureaucracies* are characterised by codified and abstract knowledge, but diffusion of this knowledge is limited and controlled by management. Coordination is therefore hierarchical. Second, in *Markets* organisation structures, knowledge is codified, abstract and rapidly diffused. Coordination is auto-regulated. Third, the *Clan*

is an organisation structure in which knowledge is not codified and concrete. Its diffusion is therefore limited due to its lack of codification and abstraction. Relations between actors in such a configuration are personal and the goals are defined and shared after a negotiation process. And finally, the *Fief* structure is characterised by codified and concrete knowledge, but the diffusion of knowledge is also limited. In this interaction structure, personal relations between members are essential for confidence and building shared values. Authority is personal, hierarchical and charismatic. The two processes of territorial exchange and diffusion of knowledge may be analysed using Boisot's model. However it does not enable the complexity of the combination process to be captured. As Carrincazeaux (2001) points out, the mobilisation of knowledge bases leads to technological complexity (complexity resulting from the application of new knowledge bases), or combinative complexity (complexity that results from the need to find connections between distant knowledge). In other words, the critical interfaces between several knowledge bases are crucial to the effective combination process**.**

In order to enrich the analysis of the nature of the knowledge essential to understand the territorial knowledge creation process, we apply the I-Space model and make the distinction between two types of knowledge: *technological knowledge* and *architectural knowledge*. This distinction refers to the works of Henderson and Clark (1990). These authors emphasise the fact that a product can be considered as a set of "components" or as a "system" (the product as a whole). Taking this distinction into account, the authors assume that the development of a product involves managing these two types of knowledge (technological and architectural). Technological knowledge deals with the components of the products βand, more specifically, with the knowledge utilised in their conception and manufacturing. Architectural knowledge is "the ways in which the components are integrated and linked together into a coherent whole". By adopting a dynamic point of view, Henderson and Clark explain that innovations are subject to *dominant design* cycles: "A dominant design is characterized both by a set of core design concepts that correspond to the major functions performed by the product and that are embodied in components and by a product architecture that defines the ways in which these components are integrated" (Henderson and Clark, 1990, p. 14).

When dominant design has emerged and has been accepted, architectural knowledge is stable and tends to be incorporated into a company's rules and practices.

Methodology

The theoretical framework proposed above will be developed and illustrated through the comparative analysis of three different territorial clusters. The first of these is the aerospace cluster known as the Aerospace Valley Pole of Competitiveness (PoC), which is the base for Airbus and its network of subcontractors. This cluster is located in southwest France. The second cluster is the Secured Communicating Solutions (SCS) Pole of Competitiveness, located in the PACA Region in the French Riviera; and the third cluster is the Fabelor Competence Cluster located in the Lorraine Region in northeast France. Each one of these three clusters is specialised in a different scientific and technological area: aeronautical and spatial industries, IT (microelectronics, telecom, multimedia and software), and environment, life sciences and technologies (forest-agribusiness-life sciences and environment), respectively.

We carried out different empirical studies on these clusters. The aerospace cluster is based on two projects: the first project was a European project, Interreg IIIb Sudoe, entitled "EADS and the territorial strategies in Southwest Europe" run in 2005; a second project is currently concerned with the organisation of this aeronautic cluster in general, and the role of hub firms in particular. This research is funded by the Aquitaine and Midi-Pyrénées regions. The third study is funded by the PACA Region and developed as part of a doctoral research project (in progress). The doctoral research project focuses on the theme of SME involvement in collaborative R&D projects and aims at identifying the territorial innovation dynamics within French Poles of Competitiveness and how they work; this analysis is then combined with the intrinsic features of SMEs to better understand how they become involved in the dynamics.

Finally, the fourth project, started in 2007, is funded by the Lorraine Region and is still in progress in the Fabelor cluster. The study is conducted on "Project number 2" (SBU 2) of the Fabelor cluster: "biotechnology, food and health".

Numerous open and semi-directed interviews were carried out in these three empirical studies: 15 interviews for the aeronautics PoC, 19 interviews for the SCS PoC, 12 interviews for Fabelor and three collective meetings on architectural knowledge identification and formalisation. For the SCS PoC, a quantitative analysis was also conducted based on a questionnaire addressed to SME members of the SCS PoC on the one hand (SMEs constitute the main actors of the pole in number), and by constructing a database listing all R&D projects of the SCS PoC, on the other hand.

Based on the previous theoretical framework, our research was designed to gather and analyse data concerning actors, transactions, proximities, and knowledge. The raw data were condensed by means of a codification system. The code categories were created on the basis of the four framework variables: actors (type, nature of governance), transactions (nature – personal or not, links density – strong and weak), proximities (geographic, relational and cognitive), knowledge (technological – codified or not, diffused or not, architectural – codified or not, diffused or not.)

Codes defining the four categories of variables were enriched through iteration between theory and empirical research. The codifying process allowed us to align data on the same variable, therefore facilitating and clarifying its analysis, and comparison among clusters.

Our cases are used to illustrate the role of architectural knowledge in the territorial dynamic of innovation. As Siggelkow (2007) points out, case research allows us to get closer to conceptual constructs (architectural knowledge), and is better able to illustrate causal relationships (here, interactions between firms, and between firms and academic researchers). As the research became iterative, going back and forth between data and theory, the progression of case events then became a source of inspiration for new ideas to refine and enrich the architectural knowledge framework and its role in building territorial innovation.

<div align="center">**Results**</div>

Aerospace Valley Pole of Competitiveness (PoC)

History of the Aerospace Valley PoC

The Aerospace Valley PoC – formerly known as Aeronautics, space and embedded systems – is the result of cooperation between the French Government and the Midi-Pyrénées Region and was given PoC status in July 2005. The local industrial firms, particularly Airbus, have played a decisive role in the creation and governance of the PoC, which is also chaired by the European aircraft company. Currently, the PoC has 530 members: MNFs, SMEs, research centres, economic development associations and public territorial bodies. This PoC results from a strong local history of development and is grounded on deeply rooted, long and intense relationships that were very hierarchical and revolved around the predominant local leaders. Historically, most linkages were based on subcontracting relations, while less importance was given to relations between SMEs and public research centres. One of the PoC's objectives is therefore to diversify the type of relationships in order to enhance collective innovation by bringing together industrial and scientific actors. In this perspective, the PoC selects projects in nine strategic business areas that include technologies such as elements of structure, embedded systems, module integration, orbital infrastructure etc. Over 200 collaborative projects have thus emerged, of which the more important ones are led by local MNFs, but geographical proximity is not revealed to be a constraint: increasing numbers of selected projects are calling for partners located outside the PoC.

A preliminary report on the projects shows that they focus on two main technological areas that are very important for Airbus: composite material and embedded systems, the latter bringing together actors from distinct sectors.

The nature of transactions

The nature of transactions is mainly contractual with customer-provider relations. One actor is predominant in the transactions: Airbus. In fact, the Aerospace Valley PoC has reconfigured its supply pyramid: the number of direct suppliers to Airbus was drastically reduced from 650 in 1987 to roughly 200 in 1993; today suppliers directly linked to Airbus are estimated to be fewer than one hundred, basically *hub firms* that organise relations with the other subcontractors in the network (Jarillo, 1988; Miles and Snow, 1992; Longhi, 2005; Kechidi and Talbot, 2009). This reduction in the number of direct subcontractors has resulted in a pyramidal organisation of the network, organised in four levels (Kechidi and Talbot, 2009):

(a) The *sub-system integrator*: firms that are involved in the conception and realisation of the technical sub-systems for which they have responsibility, not only for the production, but essentially for the innovation process. They master the architectural knowledge pertaining to a module.

(b) The *component manufacturers*: firms that supply either an independent technology (e.g., an engine) or a unit to be integrated in a more complex module (e.g., an air conditioning system).

(c) The *specialised subcontractors*: firms endowed with specific assets in a given domain.

(d) The *subcontractors*: small firms only selected on market criteria

This hierarchy, therefore, is mainly based on mastery of architectural competences shown by Airbus and the sub-system integrator.

The nature of knowledge flows

Airbus is involved in several R&D projects fostered by the PoC, which account for its dominant leader role and its capacity to combine different knowledge bases necessary for the conception and manufacture of an airplane. The possession of architectural knowledge is central in this PoC as demonstrated in the analysis of the Electromagnetic Compatibility Platform for Embedded Applications (EPEA) R&D project. The EPEA is a major structuring project, started in 2007 and supported by Aerospace Valley for three years to develop a simulation platform (as a *virtual plateau*) of electromagnetic compatibility between all the electronic components integrated in the product.

With its six million euro budget, this project brings together 16 participants, most of which are located in the Aquitaine or Midi-Pyrénées Regions in the southwest of France. Because architectural technologies are crucial, architect integrators lead the EPEA project: Airbus France (aircraft, belonging to EADS) is the principal leader, Astrium (belonging to EADS) and Thales Alenia Space are integrators for satellites. They are all located in Toulouse. Several sub-system integrators participate in the project: Thales (aerospace) in Pessac and Siemens VDO (car industry, belonging to Continental) in Toulouse. Humirel, Nexio and Flomerics are component manufacturers or specialised subcontractors. Among most important academic or research centres, CNES, Onera, Lattis, EADS-IW, are based in Toulouse.

The multinational firms (MNF) – Airbus, Thales Alenia Space, Astrium, Siemens-Vdo, Thales – possess the architectural knowledge and play a central role by defining the industrial needs in the aeronautic, spatial and automotive sectors as well as delineating the models. The other industrial or academic partners contribute their specific technical knowledge: CEM measurement techniques, the establishment of integrated circuit patterns, the software solutions required for the platform. Here, the complementarity of a specialised group of partners (or fiefs) is essential and becomes effective as a result of the combination of capacities existing within the industrial MNFs' (or bureaucracies') embedded systems developers.

The Secured Communicating Solutions (SCS) Pole of Competitiveness

History of the Secured Communicating Solutions Pole
The Secured Communicating Solutions (SCS) pole of competitiveness is located in the region of Provence-Alpes-Côte d'Azur (PACA). The pole intends to become the world reference for hardware-software integration to transmit process and exchange information reliably and securely. It aims to foster convergence among four different but related sectors with a significant presence in the region: microelectronics, telecommunications, software and multimedia. Its slogan, "from silicon to uses", reflects the project to federate the complementarities of actors throughout the added value chain from microelectronics to address the markets.

The case of SCS PoC is interesting: empirical studies (Daviet, 2003; Mendez, 2008; Garnier and Lanciano-Morandat, 2008; Gadille and Pelissier, 2008; Dang and Longhi, 2008, 2009), coupled with the review of the history of development in the territory have evidenced that the SCS PoC actually results from two different clusters of firms specialised in ICT located in the same region with two distinctive dynamics of innovation. Furthermore, the two clusters have arisen out of traditional French industrial and regional policies, driven by exogenously centralised processes.

Indeed, the two clusters have grown independently according to very different organisational designs: one driven by internal oriented processes, the other by external oriented processes.

The cluster located in the western part of the Region (which department reference number is 13) – the Marseille cluster – was born out of a voluntarist policy, typical of French industrial policies, aiming at developing the microelectronic sector. The "national champions" were requested to achieve this goal; a firm, Eurotechnique, was created with US partnership to supply the technology. The merger of these activities with an Italian group spawned ST Microelectronics; a group of engineers from ST rapidly founded Gemplus; Atmel was also created from acquisitions of the original seed (Zimmermann, 2000; Daviet, 2003). Thus, leaders of microchip fabrication,

cards, digital security activities, leadership mainly built from innovations, have endogenously emerged from the original public investment, resulting in a cluster of complementary large firms built on a common knowledge base. These large firms have built up an important network of subcontractors, usually SMEs involved in the production process.

The cluster located in the eastern part of the Region (which department reference number is 06) – the French Riviera, (Sophia-Antipolis cluster) – emerged from the creation of Sophia-Antipolis in the 1970s. The "technopolis" was created to attract high value added activities in the region, and to implement a new local development strategy to strengthen a tourism-driven economy. The project was heavily supported by the public policy of decentralisation with substantial public investments in telecommunication and transport infrastructure. Nevertheless, in contrast to the western part, the initiative was developed without any precise technological project (Longhi, 1999). After the decentralisation of large French (public) firms, an international marketing strategy tied in with the ongoing globalisation process succeeded in attracting multinational companies in the microelectronic, software and telecommunication industries (Texas Instruments, Philips, Infineon, HP). Research centres, and higher education institutions followed the location of multinational companies. In this sense, the cluster is a "false" science park; it is mainly built on large international firms, attracted by infrastructures and the perspective of penetrating European markets. As a result the cluster is rich in external linkages, but deprived of internal relations among firms, largely involved in stand-alone local activities. The crisis of the nineties, the rise of the Internet and mobile technologies, in which many actors are involved, have led to incipient internal processes in the cluster.

The PoC provides incentives for firms in the cluster to formalise R&D projects in order to access subsidies associated with the policy. In some way, it plays the role of enlightener of the clusters' innovative capacity, of the nature and location of the firms involved in these innovative processes, of the possible obstacles to projects from "silicon to uses" and to merge the two original clusters into a new one. The analysis of the database of the R&D projects, identified by the governance structure of the SCS PoC and financed if selected, offers some valuable information. The R&D project database provides quantitative information on the type of actors involved in the projects, their number, sector and location, which gives some initial insights into the innovation dynamics of the cluster (Dang and Longhi, 2009). From 2006 to 2008, the PoC identified 157 R&D projects, but only 47 were selected for funding. Among them, 64% of the PoC funded projects are led by a firm located in the Marseille cluster, revealing that this cluster has a far better collaboration dynamic when the PoC's R&D projects are analysed.

Information concerning the location of the partnerships in the project is also important and is summarised in the following charts:
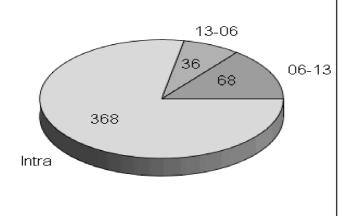
Figure 2: Location of R&D project partnerships

13 - 06: Projects in partnerships between the two clusters whose leader is located in the Marseille cluster and whose members (36 in total) are in the Sophia-Antipolis cluster

06 - 13: Projects in partnerships between the two clusters whose leader is located in the Sophia-Antipolis cluster and whose members (68 in total) are in the Marseille cluster

Intra: Projects in partnerships between actors from the same cluster (which only are 06 or 13 - (368 members - the department reference number is 06) – in total).

The chart shows that the R&D projects are mainly intra-cluster projects. In fact, very few projects involve partnerships between the two clusters: of the total number of 368 partners involved in PoC projects, only 36 partners from the Sophia-Antipolis cluster are involved in a project led by the Marseille cluster, and only 68 partners from the Marseille cluster are involved in a project led by the Sophia Antipolis cluster.

The results show that the western Marseille cluster is more efficient in obtaining support from public policies. This is particularly true in the case of SMEs. SMEs from Marseille are traditionally involved in subcontracting processes, and can easily join R&D cooperative projects. The same does not occur in Sophia Antipolis where the involvement of SMEs in local projects is more difficult. Traditionally, SMEs in Sophia Antipolis are open to external linkages, just like the large firms. Much of the innovative activity run in Sophia-Antipolis is thus not necessarily captured in the SCS PoC activity.

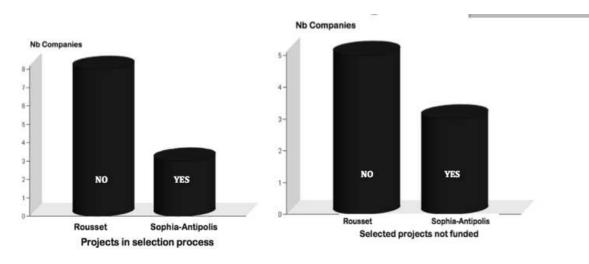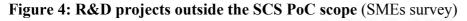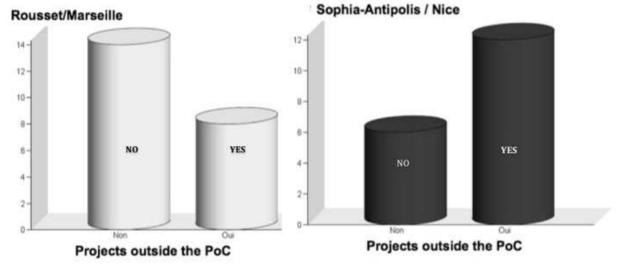The following charts, based on a survey of the SMEs in the two clusters, attest to this fact:

Figure 3: R&D projects fostered by SCS PoC (SMEs survey)

Figure 4: R&D projects outside the SCS PoC scope (SMEs survey)

Surprisingly, in the case of innovation projects that are outside the PoC programme, the configuration is completely reversed. Sophia-Antipolis SMEs are involved in a substantial number of projects outside the PoC programme (mostly European projects) while the number for Marseille SMEs is lower.

An analysis of the nature of the transactions and of the knowledge flows related to the R&D projects and innovative activities in the cluster can explain these facts.

The nature of transactions and knowledge flows within the Marseille cluster

The nature of transactions
The nature of transactions in the Marseille cluster is mainly of a local customer-provider basis on the one hand, and technological on the other. The specificity of the Marseille cluster lies in the fact that contractual and technological transactions specifically concern the microelectronic manufacturing process.
The transactions are indeed structured by vertical interactions in the microelectronics sector and revolve around the *fabs*, the microchip fabrication plants.
"There are in fact Multinational firms (MNF) such as GEMPLUS, ST, ATMEL that are like AIRBUS, i.e., surrounded by a network of SMEs. There is a whole network of subcontracting SMEs that provides almost everything they need!"   Mr   Luc
Jeannerot**,** Director of ARCSIS[4]

Gemplus's development underpins the creation of SMEs specialised in smartcards that develop designs and applications specific to Gemplus's needs, but also SMEs that decide to position themselves with complementary services for foundries such as production machines or chemical products for maintenance of equipment, as underlined by Mr Jeannerot:
"MNF give rise to SMEs in the microelectronic sector. However these SMEs remain subcontractors, or become specialised in side areas of expertise outside the microelectronic industry that are not the core competence of MNF. Small firms will develop MNF needs such as maintenance of equipment, providing retrofit equipment necessary to MNF's fabs performance"

The nature of transaction can therefore be characterised as mainly technological in order to develop new markets or new technologies in new firms (spin-outs), or contractual (subcontracting) transactions between a few major companies (Gemplus, STMicroelectronics and Atmel) that decide at the local level on which technological orientations and new services to develop. On this matter, the R&D projects database shows that of 157 selected projects for the whole region, 66 projects are initiated or involve at least one of the three companies (11 projects for Atmel, 16 projects for GEMALTO (ex-Gemplus) and 33 projects for STMicroelectronics) which represent a striking number when considering the projects involving the western part of the PoC. Mr Jeannerot adds, "I do think the hierarchy rule works here. It's clear that Marseille MNFs have established themselves as the leaders. The coordination modes are clearly hierarchical".

In addition, the nature of transactions accounts for the density of local interactions: there is a high level of cognitive proximity and cooperation is well established, which leads the director of ARCSIS to say that, "in the microelectronics industry, cooperation relations are very well established and stabilised; solidarity exists".

The nature of knowledge flows
Thus, figures are sometimes misleading. When the survey shows that SMEs from Marseille are far more integrated in innovative projects than SMEs from Sophia, it appears that the three MNFs actually foster most of R&D projects in the western part of the PoC even though they are officially initiated by SMEs. "I think that the criteria set by funding commissions are so restrictive that in each project there should be an MNF that manages SMEs. Of course SMEs' competences are very valuable, but it is the MNFs who decide in the sector."
                        Mr Jean-Marc Sarat [5]

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[4] ARCSIS is the trade association for the microelectronics and semiconductor activities in the Provence-Alps-Riviera (PACA) region
[5] Manager of SMEs department of the governance structure of the SCS PoC

The main reasons why SMEs are integrated in many R&D projects is not only their innovative capabilities, but also due to the underlying mechanisms. Firstly, the relational dimension of interactions has shown that major firms are the local leaders and highlights their power of knowledge attraction and central role in innovation decision making. Secondly, the nature of knowledge flows is specific: the vertical interactions characterising the transactions between the three MNFs, the *majors*, and local SMEs are actually of two different kinds.

On the one hand, they are complementary, that is to say that SMEs – mainly derived from spin-offs – develop technologies that are complementary to the majors' technologies and are clearly defined with the majors:

"Most SMEs from the western part of the Region perceive their network as somewhat oriented towards the MNF decision makers. Recently in the SCS PoC board of directors meeting, we observed precisely that there are top decision makers that leverage the development of a network of SMEs derived from clearly defined technical requirement specifications, or from know-how nurtured by some individuals in an MNF and developed in small firms or from one small firm to another"   Mr Vincent Prunet [6]

On the other hand, some SMEs have identified side services for foundries with complementary knowledge in completely different areas of expertise for the maintenance and well functioning of the fabs, such as chemistry or optic expertise, as in the case of OSIRIS, a project selected by the PoC and led by CEPRIM technology that aims at developing a cleaning machine and an electrochemical micromachining through selective gate etching. Mr Jeannerot, a member of the selection commission, explains how the project idea was born:

"SMEs officially initiate the project even though the idea is originated by an MNF. This type of project, such as OSIRIS, aims at developing maintenance of equipment axis like testers. The small firm project leader has already worked for ST and ATMEL for eight years and is now collaborating with universities to improve their services and test the result in an MNF."

Thus, SMEs forming a dense ecosystem around the three major firms tend to bring a competence that completes decision-makers' competencies. For this reason, the SME expert Mr Sarat says that, "Subcontracting companies are not particularly innovative. For example, in the microelectronic sector, an SME that produces plastic injection machines for the manufacture of thinner and lighter smartcards, for GEMPLUS, are actually not really innovative. It is Gemplus that has told them 'Well, I need a thinner and lighter smartcard, 500 mg less…' etc."

Nevertheless, the competence developed by the firm that cooperates with the majors exclusively follows their needs. In other words, the three main corporations are building partnerships with surrounding firms to develop what they need, but do not want to or cannot develop themselves:
"There are therefore innovative SMEs that don't have to wonder how to integrate in an innovative project as they know their role and place. The entry cost is therefore diminished. In the manufacturing process, everything is very well organised, you know which process you are in and what the next process will be. The manufacturing rules are very well defined"
                                          Mr Bruno Delepine[7]

The nature of architectural knowledge is thus controlled diffusion. The *dominant design* heading the knowledge flows in such interactions is clearly defined and stabilised in the manufacturing and production processes of the microelectronic sector: the three major companies hold the architectural knowledge enabling the existence of a stabilised dominant design. The dominant

design makes collaborations easier as the complementarity of knowledge is clearly determined; moreover, the clients to address and the needs to compensate for are already identified.

In sum, the transactions within the Marseille cluster are clear evidence of the fief and bureaucracy types. In this interaction structure, relations between members of the clusters are based on established and clear vertical partnerships, a clear roadmap, and shared but controlled knowledge by a few main heading companies (bureaucracy) that hold architectural knowledge and handle a whole network of SME followers (fief) with specific and complementary knowledge.

The nature of transactions and knowledge flows within the Sophia-Antipolis cluster

The nature of transactions

Within the Sophia-Antipolis cluster, the nature of transactions is characterised by a very wide variety of relationships explained by the large range of sectors located in the cluster. In fact, Sophia is characterised by transactions in the other phase of the microelectronic sector: the design process, as well as by the software, telecom and multimedia sectors. In these sectors, the nature of transactions is mainly driven by the development of technology applications. The Sophia-Antipolis cluster presents a multitude of actors in different sectors without any dominant firm or institution that would lead the cluster orientations.

The nature of transactions in the microelectronics design process is quite particular: very few or practically no technological collaborations. Indeed, by focusing on projects and in processing interviews, it appears that design activities constitute a specialisation of Sophia's microelectronics firms. But, their level of cooperation is very low. According to the Director of ARCSIS, in the design process, collaborations are more difficult than in the production process in so far as proposing a new design consists of adding a new solution to the market that would compete with another type of design. Mr Jeannerot confirms that:

"in the microelectronics design process, each small firm conceives its own new design, so how can others contribute to it? Firms like Cadence or Synopsis can add their software added value. But apart from that, the other design SMEs cannot collaborate because either they are not doing the same thing at all so they cannot be complementary, or they are doing the same thing and they become competitors. In contrast, in the fabs, MNFs necessarily need knowledge in the maintenance of machines, new materials, innovative materials"

This renders knowledge sharing more difficult and explains why technological partnership transactions are almost inexistent.

In the three other sectors, (telecom, multimedia, software) the Sophia cluster has developed highly dense external interactions driven by external markets but with very poor local interactions. The lack of local interactions has been a long-standing issue that has given crucial importance to associations such as SAME or Telecom Valley created to clearly display the specific competences of Sophia-Antipolis. Internal interactions subsequently began to emerge, and the dynamic of interactions finally took shape as a result of clubs and associations, but the dynamic of cooperation is still weak.

"Here, in Sophia, the lack of a dynamic is still evident (…) We are still in a logic of exchange: social networking, exchange of tips etc. But there is still no logic of cooperation. In Sophia, main cooperation continues with external relations"

Claire Behar [8]

Nature of knowledge flows

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[8] Economic Intelligence manager at Syndicat Sophia Alpes Maritimes (SAM), whose mission is to help local actors develop global, concerted economic strategies for the territory.

In the microelectronic design process, the complexity of knowledge is high: a small firm can actually only propose simple designs or very specialised ones with market applications that are very easy to penetrate, as Mr Delepine claims:
"SMEs are developing simpler and often very specialised designs compared to MNF designs, and their design is often easier to apply as well."

The complexity of knowledge at stake in the design process has led large firms to internalise as well as to attribute increasing value to the capacity to combine knowledge. In fact, the design of the core of a microprocessor is called "the architecture" which term is far from being neutral. "It is the integrator's role to master architectural knowledge. It is the MNFs that have such knowledge on how to combine expertise" says Mr Delepine, who also claims that in his firm the design competencies are considered as the "apple of its eye". This self-explanatory quote shows how risky it is to share knowledge, except perhaps, in terms of applications.
This is an insight into why fewer PoC collaborative projects are led by the Sophia cluster than the Marseille cluster. The core knowledge about the microelectronic design process cannot be shared. Instead, two types of projects emerge from the Sophia-Antipolis cluster.

The first of these are projects focused on a specialisation that adds value to the end product of microelectronic design (integrated circuits, microprocessors, etc.). For example, R&D projects such as MaXssim, a project that aims to develop a secure solution for mobile internet multimedia, involves microelectronics SMEs such as Trusted Logic. This small firm is a leading provider of open, secure software for smart cards, terminals and consumer devices, and creates the foundations for converging digital services at the crossroads of telecom, banking, transport, and government. The firm is involved in seven different projects fostered by the PoC and has signed several collaboration agreements with other microelectronic companies.
Mr Prunet, the company's strategy manager, underlines that Trusted Logic combines software expertise to secure smartcards. Their knowledge is specific and complementary as well as very clearly defined and codified. He confirmed that, "We have an intellectual property culture; we have patented exactly 30 innovations".
Collaboration is therefore effective only when interest lies in personalising or specialising integrated circuits, moreover. "It is more difficult to create a new circuit than to write some lines of codes that personalise a circuit" according to Mr Sarat.
The intrinsic nature of the design process – defined by a system containing several sub-units that must be controlled simultaneously by a critical interface – is a hurdle to collaboration. This complexity requires architectural knowledge. Consequently architectural knowledge becomes precious and therefore not diffused or shared.

The second type of project are those that are transverse to the sectors present in the cluster (telecom, software and microelectronics), but focused on new application of technologies and new services. In this kind of project, combinations of knowledge are, in essence, potential. If the complementarity of knowledge is high, the dominant design structure is far from easy to identify. Indeed, competences that are mostly oriented toward services, uses, and the application of technologies can lead to the development of a multitude of different markets. Each actor has a competence in several areas of expertise. In addition, technology applications work in the opposite way to the microelectronics design process: the system is modular; in other words, when there is an innovation, the new ways of combining knowledge in a sub-system do not change the overall system. Therefore, there are as many design structures as there are possible combinations. There is no stabilised design that would leverage collaboration by structuring the cluster innovation dynamics. Mr B. Delepine, admits that in contrast to the microelectronics fab activities, in applying technology activities it is not easy to know how to collaborate, with whom, for what market and when: "In the fabs it is true that the need is easily defined, while for technology application, it's far more difficult". Combining complementary knowledge is a delicate process

and involves many difficulties in creating a real local dynamic of collaboration. Moreover, the output of the project is far less guaranteed than fab oriented projects. This also explains why fewer projects are selected from the Sophia cluster.

In sum, this cluster presents market-like interaction structures where knowledge and information are codified, abstract and rapidly diffused thanks to informal transactions channels, "reverse spin-offs" and efforts to codify and standardise knowledge through different institutions (ETSI for the ICT industry, W3C for the Internet). The coordination is auto-regulated with no major firm or institution heading either the cluster or the stabilised architectural knowledge, which notably explains the lack of a local dynamic of interaction.

The Fabelor competence cluster

Fabelor pole history

The Fabelor competence cluster, "Forêt-Agroalimentaire-Biotechnologie-Environnement Lorraine", created in 2007, is the most recent cluster. Its overall objective is to coordinate research, universities and industry. The cluster is divided into three Strategic Business Units (SBU); the analysis focuses on the second SBU entitled "Food safety and expertise". The main objective of this second SBU is to evaluate the effects of diet on health, notably through the analysis of antioxidant biomolecules. The SBU has two main projects. The first, Agrival, aims at evaluating the effects of chemical or biological field contamination on the end consumer. The second project, Nutrivigène, contributes to the understanding of links between food and diseases throughout the different stages of life.

The SBU is composed of 15 research teams from academia, mainly from two research institutions:
– the INPL and the CHU – located in a neighbouring geographical area. The 15 research teams are divided as follows (according to Agrival or Nutrivigène projects):

- 6 biology teams and 1 physics team from INPL, working on Agrival
- 7 health care teams, from CHU, working on Nutrivigène
- 1 computer science team, with researchers from INPL and CHU, are sporadically involved in both the Agrival and the Nutrivigène projects on specific points.

The teams working on each project have high cognitive proximities (biology for Agrival and health for Nutrivigène) and high organisational proximity (INPL institute for Agrival and CHU Institute for Nutrivigène). The area of expertise and the work cultures vary significantly from one project to the other.

It should also be noted that besides the 15 research teams, five food industry companies (St Hubert, Milk cooperative, Euroserum, Nestlé Waters, Alliance Fromagères) are members of the project, but will only take part in the project during the final stage of the programme.

The nature of transactions

On the whole, transactions between project members are of a scientific nature: exchange of information and knowledge, sharing of scientific protocols, and sharing of experimental equipment. However, it should be noted that R&D projects are often constituted with the idea of applying for public subsidies. In the first kind of transaction, relations are mainly interpersonal and informal; in the second, relations are contractual and in general involve the research institution directors. Within each research institution, researchers work together on numerous projects and publish joint articles on their scientific results. The relations between researchers are very close. The research institutions of the INPL institute involved in the Agrival project have developed very intense work relations over a long period: co-direction of graduate students or doctoral students, cooperation relations between projects. This cooperation is necessary when the projects involve distinct know-how that is mobilised at different stages of the projects. The teams from CHU involved in the Nutrivigène project have similar characteristics. However, they are differentiated by a single characteristic: at

INPL collaborations between research centres are initiated by the researchers themselves, while at CHU the decision to collaborate is taken centrally by the research centre directors.

Importantly, this is the first time that teams from INPL and from CHU have cooperated on the same project. Efficient cooperation is particularly necessary for the project as the Fabelor cluster has 7 billion euros of funding over a seven-year period. The Fabelor Manager states that, "The heads of research centres [at INPL] attend the meetings when there is an evaluation of planned investments (…), JL Guéhan always attended the meeting for the purchase of materials (…), we discuss with JL Guéhan when there are decisions concerning first investments for the CHU".

One of the research centre heads contributing to the Agrival project explains that "Stéphane Désobry [Fabelor Manager] gathers people to discuss the priorities of investments, and of what is required by the region. Then Stéphane informs about the budget, and jointly we decide how the budget should be allocated to science" (G. Rychen).

The nature of knowledge flows

The research and development activities within each research centre involved in the Agrival and Nutrivigène projects principally mobilise specific knowledge, namely, technological knowledge. This knowledge is partly codified in the form of publications. Nonetheless, each research centre has important know-how, of a more tacit nature, notably in the choice of methods and experimentation protocols. The partnership culture is more developed at INPL, so and so it is in Agrival project, however, the capacity to combine knowledge and know-how from different research centres in specific projects are neither codified nor capitalised. Furthermore, these current projects are the first to have involved so many researchers and research centres to date, and for such a general and long term objective, the conception of antioxidant biomolecules that would have positive effects on health through food.

In sum, even within the Agrival project, architectural knowledge is partial, distributed and tacit.

Fabelor's project was therefore developed to enhance potential synergies between the research centres headed by INPL and CHU, with the idea that each research centre could contribute, in its own area of expertise, to the conception, characterisation and testing of these antioxidant molecules.

In reality, the combinations proved difficult to carry out, and cooperation on the project has not yet been fully activated. The director of one research centre at INPL, and manager of one of the Agrival subprojects, says that "all people in the research centre are involved in Fabelor by giving synthesis notes and reports of the scientific production. However, they are not directly involved in the research activities because there is no link with the other project teams, and there is a lack of scientific coordination and animation […] currently, we see more links with external research centres, and there is no joint project with another research centre from the Fabelor cluster" (G. Rychen).
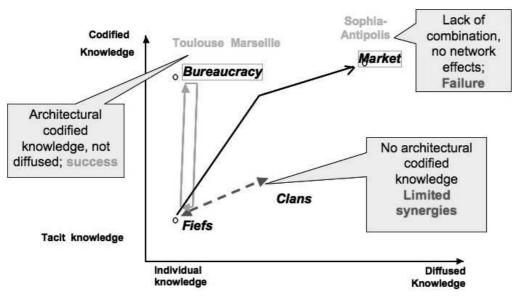
More than six months, six individual interviews, and three joint meetings were necessary to bring about a shared collective design and to combine knowledge for the effective operation of the Agrival project. Another Agrival subproject manager explained that the Fabelor cluster, "is not however supported by any practice of knowledge capitalisation. If we know all the teams and their competences in biology (those who have the same scientific knowledge bases as well as those who have complementary knowledge), we don't, however, really know about the competences in health. It is a very good exercise for us to stand back; we really don't take enough time to think about it and we don't have anything to help us to capitalise" (Ch. Sanchez). This is an initial step towards the formalisation of architectural knowledge, essential to support the development of this project.

To conclude, cooperation between the Agrival and Nutrivigène projects is still faltering because actors have difficulties in specifically identifying relevant cooperation (total lack of architectural knowledge).

An important fact is that the difference in culture between the two projects restrains the build-up of collective and shared architectural knowledge. The manager of Fabelor claims that the organisation of a scientific reporting day, "would make the CHU researchers come and would enable them to see what is in progress in the Nutrivigène project" (S. Desobry).

Discussion and conclusion

The first results evidence the existence of highly different territorial dynamics, and the importance of the concept of architectural knowledge to analyse and characterise them. The analysis of architectural knowledge enables enrichment of the concept of combinative complexity introduced by Carrincazeaux (2001).

A brief summary of these territorial dynamics is now provided. Three main distinctive dynamics can be identified, depending on the nature of the interactions implemented locally. The first, seemingly quite efficient, is characteristic of the aerospace pole of competitiveness (PoC), and the Marseille side of the SCS PoC (west side of the SCS PoC geographical area); the second refers to Sophia-Antipolis, located on the east side of the SCS PoC geographical area; and the third corresponds to the Fabelor pole. These dynamics are illustrated in the following figure:

The Toulouse and Marseille poles are made up of large firms, SMEs and research institutes. Their knowledge bases are characterised by the existence of a codified dominant design controlled by the large firms in the poles (Airbus – aeronautics in Toulouse, ST Microelectronics, Gemplus and Atmel in Marseille); they organise the combination of the technological knowledge held by the SMEs, which are represented as many fiefs. The aerospace pole is illustrative of this phenomenon. Indeed, its hierarchy is mainly based on the mastery of the architectural competences displayed by Airbus and the sub-system integrator. In contrast, Sophia-Antipolis, for instance, is characterised by highly varied knowledge bases, from microelectronics to computer science. This variety increases the combinative complexity and, in sum, few synergies are achieved locally (Lazaric, Longhi and Thomas, 2008). The cluster has no specific dominant design and most of its industrial and academic actors are involved in projects of innovation outside the pole. Moreover, the cluster

is oriented towards services, uses, and IT applications, which leads the cluster to make significant efforts in codifying knowledge, notably through its standardisation. Indeed this codification process is carried out by major European institutes such as ETSI, the European Telecommunications Standards Institute, located in Sophia-Antipolis, which seeks to produce the telecommunications standards that will be used throughout Europe and beyond, or like the development of W3C, The World Wide Web Consortium, which develops interoperable technologies (specifications, guidelines, software, and tools) to bring the web to its full potential; and by doing so, the cluster has reinforced market relations.

The Fabelor cluster is more recent; in contrast to the others, which are generally made up of firms, it consists mainly of public research institutes. The teams involved predominantly belong to two institutions from Nancy, the INPL[9] and the CHU[10] (from the UHP[11]). The first interviews conducted show that these institutions correspond to two clans where the actors belonging to the institutes of research (fiefs) are used to cooperating. The combination of knowledge between these clans is today critical, as underlined by the region's first evaluation of the Fabelor project in November 2008. It is useful to emphasise that even within a single clan, architectural knowledge is fragmented and tacit, making effective combinations difficult to carry out. In order to improve these capabilities to combine, actors from INPL specialised in the conception, formulation, characterisation and analysis of new molecule biodisponibility have attempted to formalise this process: in short to codify a dominant design. Various meetings have been necessary and the design is not yet stable. It is also planned to better organise the process within the teams from CHU and between the two clans so as to formalise the process as a whole. Once this has taken place, the codification of architectural knowledge will modify notably and improve the process of innovation in this cluster.

In the contrasting case, the existence of architectural knowledge is pivotal to innovation. The possession of this knowledge by a specific category of actors is a source of power and grows as a structural element of the cluster's innovation dynamics (aeronautics PoC and Marseille cluster). Their codification and sharing seems to be, as in the Fabelor case, a key condition for implementing an effective local innovation process.

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[9] INPL - Institut National Polytechnique de Lorraine – one of the three universities in Nancy.
[10] CHU: Centre Hospitalier Universitaire.
[11] UHP – Université Henry Poincaré – one of the three universities in Nancy, Nancy I.

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