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► **To cite this version:**

Rachel Levy, Damien Talbot. Control by Proximity: Evidence from the "Aerospace Valley" Competitiveness Cluster. *Regional Studies*, 2015, 49 (6), pp.955-972. 10.1080/00343404.2013.840721 . hal-02333380

**HAL Id: hal-02333380**

**<https://hal.science/hal-02333380>**

Submitted on 25 Oct 2019

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# **Control by Proximity: Evidence from the “Aerospace Valley” Competitiveness Cluster**

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**Regional Studies vol. 49, n°6, pp. 955-972**

Abstract: This article is concerned with the links that exist between control of inter-organisational relationships and effects of proximity. We propose a theoretical framework which explains how geographical and organisational proximities reinforce formal and informal control mechanisms. This framework is then used to analyse mechanisms of control by proximity in a French aerospace cluster. We observe that formal and informal control is concentrated in a small number of groups located near the majority of the establishments members of the cluster. We also show that informal control mechanisms require a stronger geographical proximity than formal control mechanisms in order to operate.

Key words: Proximities, controls, clusters, collaborative R&D projects, aerospace industry.

JEL classification: L14; L62; R38; R58.

## **Introduction**

Approaches dealing with the control of relationships between organisations and with the role of proximity in the dynamics of interactions between organisations still appear to remain separate from one other. They have, nevertheless, numerous points in common. Work on control of relationships throws light on the necessity of controlling the risks inherent in any relationship in order to ensure its durability. The proximity approach on the other hand tries to determine the conditions which exist at the inception or the reinforcement of a relationship. The sharing of standards, beliefs and values is a control mechanism (e.g. OUCHI, 1979; DAS TENG, 2001), whereas proximity-orientated authors insist on the sharing of a common cognitive framework as a pre-requisite for any coordination (e.g. TORRE and RALLET, 2005; BOSCHMA, 2005; CARRINCAZEAUX *et al.*, 2008a; RYCHEN and ZIMMERMANN, 2008). On the one hand, trust is perceived as an instrument of control (DEKKER, 2004), on the other, as an essential ingredient of proximity (DUPUY and TORRE, 2004). The particular objective of control is to orientate interactions, which are themselves largely fashioned by their social and geographical integration as shown by the proximity-orientated analysis.

These common points suggest that a convergence of the two strands of research could be fruitful. For example, the question of the possible influence of geographical proximity on inter-organisational control mechanisms has yet to be posed: in other words, does geographical proximity favour control over a partner? More generally, this line of questioning can be extended to the non-spatial dimension of proximity, to investigate the role of proximity, in all its dimensions, in control mechanisms. The principal objective of this work is to respond to this question and to construct, in an original way, a theoretical framework allowing an understanding of control mechanisms in terms of proximity.

This question of the link between control and proximity is particularly pertinent in the case of cooperation between organisations operating in the same locality where the aim is innovation. The theoretical framework will thus be used to analyse the case of collaborative Research and Development (R&D) projects undertaken within clusters set up in France and known as competitiveness clusters<sup>1</sup>. Centres for the creation and exchange of knowledge, the relationships within clusters are often studied from the point of view of sharing and of the necessary recombination of complementary knowledge, linking innovation and proximity with the objective of learning by the partners from one another. Now, this link between innovation and proximity must also be examined in terms of the control exercised by one partner on another: in effect, the control of a relationship which necessitates the exchange of existing knowledge in order to produce new, common knowledge is a condition *sine qua non* of its durability. Particularly sensitive to opportunist behaviour, the process of joint innovation and the sharing of the results of such innovation must be controlled, the different types of proximity playing a role in this control and in the probability of the success of the innovation.

We propose to study the Aerospace Valley cluster, located in the southwest of France, specialising in aerospace activities. Like all competitiveness clusters, its objective is to favour collective innovation between co-localised partners by profiting from the positive effects of proximity. To do this, it gives financial support to collaborative R&D projects between close partners. Now, these projects are characterised by the significant domination, and thus control, by big industrial groups. More precisely, we evaluate the different forms of control and of proximity within different Strategic Business Units (SBUs) of this cluster using in particular the methodology of analysis of social networks.

This study is presented in three parts. In the first part, we present our theoretical framework, describing mechanisms of control by proximity. In the second part, we present our empirical

and methodological choices. Finally, we present and discuss our principal results in the third part.

## 1 Theoretical framework: control by proximity

We present successively the principal mechanisms of the two categories of control which are traditionally distinguished, next we characterise the dimensions of proximity and finally we suggest how these approaches articulate with one another by defining control by proximity.

### 1.1 Controls: definitions and mechanisms

There are at least two major categories of reasons to explain the failure of a relationship between two organisations: opportunist behaviour by the partners and/or a lack of coordination (DEKKER, 2004). Control of the relationship thus aims to prevent such failure and, more generally, to reduce the risks and the costs inherent in any relationship based on an exchange. From a behavioural point of view, control becomes a particular type of relationship through which an individual or an organisation influences the action of another individual or organisation to the benefit of the former (NOGATCHEWSKY, 2003). By dissuading opportunist behaviour and by maintaining the convergence between actions, control helps organisations to achieve their objectives (KIRSCH, 1996).

The question of the control of an inter-organisational relationship, the case which concerns us here, is approached in the literature from different angles: shared control (AREND, 2006), strategic alliances (DAS and TENG, 2001; DEKKER, 2004), networks (KAJUTER and KULMALA, 2005), joint-ventures (CHALOS and O'CONNOR, 2004; KAMMINGA and VAN DER MEER-KOOISTRA, 2007), control of the supply chain (DONADA and NOGACHEWSKY, 2006; MUDAMBI, 2008), etc<sup>2</sup>. The majority of these studies distinguish two complementary types of control: formal and informal. Formal control is based on

contractual engagements between partners and on objectifiable, explicit mechanisms. The sanctions applicable in the case of inappropriate behaviour are essentially legal. It aims:

- firstly, to control results with the help of various highly codified mechanisms. These control mechanisms may be *ex ante* or *ex post* in relation to the objective of the control (DEKKER, 2004). *Ex ante*, includes, for example, the establishment of objectives which clarify the expectations of the partners. *Ex post*, the disparity between actual and expected performance is measured using evaluation systems drawn, for example, from management control (CAKER, 2008);
- secondly, to orientate behaviour *via* standardised *ex ante* procedures specifying expected behaviour, schedules, rules. The conformity of these behaviours in relation to these same procedure and rules (OUCHI, 1979) is then evaluated *ex post*.

Formal control supposes that the results are easily measurable and the behaviours relatively programmable. If this is not the case, one can associate with it informal control founded essentially on tacit mechanisms, that is to say self-regulation dependent on the psychological and social characteristics of those who draw them up (GROSSETI and BES, 2001). In the case of inappropriate behaviour, the sanctions tend to be moral. Trust<sup>3</sup> proves to be a particularly efficient informal control instrument in inter-organisational relationships (DEKKER, 2004). *Ex ante*, this informal control mechanism allows the user to select a partner in terms of its supposed capacity to satisfy common interests and of the skills which it can deploy, in other words, its reputation. *Ex post*, it emerges over time with repeated and successful interactions (achievement of objectives, resolution of problems, loyalty, *etc.*) but also because each partner becomes more familiar with the skills and expectations of the other. Formal and informal control are related by links of a complementary nature. Whereas formal control reduces the motivation to adopt opportunist, or simply less effective, behaviour, trust reduces, in a complementary fashion, the fear that such behaviour will arise in the first place

(DAS and TENG, 2001). BORNAREL (2008) notes that trust curbs opportunist behaviour without resorting to formal mechanisms because loss of such trust carries a high cost. Resorting to trust would appear to be more justified in very uncertain situations with strong interdependence: when formal control of behaviour and results are limited, trust becomes an informal, implicit means of ensuring control. Furthermore, excessive use of formal control can destroy any trust that may have built up during interactions, thus giving the impression that one partner distrusts the other (DAS and TENG, 1998).

Above and beyond trust, the convergence of interests and the sharing of standards, beliefs and values within a social group are also strong informal control mechanisms, phenomena called “*clan control*” by OUCHI (1979). The author is referring here to the social pressure which is exerted on each member of an organisation and which orientates his behaviour in favour of the interests of the group and in accordance with its common values. Respect for the rules is rewarded by the fact of belonging to a community whose members have been selected (KIRSCH, 1996).

Once set up, control mechanisms allow the process of social interactions to get under way, which in turn nourishes the trust between the partners thus becoming self-reinforcing. The control mechanisms are no longer regarded as a curb on interactions; on the contrary they play a strategic role in their perpetuation, securing exchanges of information and of knowledge and the learning processes necessary, for example, for collective innovation. Next we question whether these two forms of control are exercised by the same actors and whether proximity has an impact on the exercise of these two forms of control.

## 1.2 Proximity: definitions and mechanisms

The proximity approach starts from the principle that geographical location and the position in a network of interactions condition the economic activities of organisations, in the sense

that the characteristics of social and geographical integration have for vocation “*the conditioning of the probability of the emergence of a relationship or of the reinforcement or weakening of an existing relationship*” (PECQUEUR and ZIMMERMANN, 2004, p. 20). The approach aims to determine what conditions are necessary for the emergence and/or the reinforcement of a relationship.

According to this approach, a participant in a network is present both “here and elsewhere”. Here because it is located in a geographical space within which it has “neighbourly” relationships, elsewhere because the participant obviously has long-distance relationships with other participants. It is true that one can be “close” to someone while being geographically remote from them: proximity then presents, besides the geographical dimension, a non-geographical dimension allowing one to pose at the same time the question of location and of organisation. Even if the number of dimensions distinguished may vary according to the author, all agree that there is a seminal distinction between geographical and non-geographical dimensions of proximity (CARRINCAZEAUX *et al.*, 2008b). This is the case in France where the debate concerning the different forms of proximity has crystallised around the question of whether it is necessary to conserve a distinction between institutional proximity and organisational proximity, alongside geographical proximity. In our case, proximity will be understood as an institutional fact presenting two dimensions, geographical and organisational (TALBOT, 2010). In the same way, whatever the theoretical position adopted concerning the different forms of proximity, all the authors of the “proximity school” agree that in the majority of cases proximity favours the emergence and the development of innovation: “*The more proximity between actors (in whatever form), the more they interact, the more they learn to innovate*” (BOSCHMA, 2005, p. 15).

### 1.2.1 Geographical proximity

Geographical proximity tackles the question of the conditions of localisation of activities (PECQUEUR and ZIMMERMANN, 2004). It is not the inverse of the metric distance. Distance, which leads one to think of separation, is a quantitative expression of the relationship between two objects and/or two individuals. Proximity is a qualitative judgement, necessarily subjective and difficult to measure, of a small geographical distance. Qualitative, it becomes a unit of social measurement with two fundamental values: “to be close to”, “to be far from”, constituting the extremities of a single continuum (TORRE and RALLET, 2005).

Through its effects geographical proximity favours the emergence and/or the reinforcement of a relationship in at least two ways. In the first place, geographical proximity facilitates face-to-face interactions, which themselves facilitate the exchange of knowledge, particularly of tacit knowledge (POLANYI, 1983; GERTLER, 2003). We come back to the classical idea according to which physical space is structured by transport and telecommunication infrastructures. It then constitutes a physical framework favouring the circulation of information, of physical goods and of individuals and facilitating face-to-face interactions. In the case of permanent geographical proximity, it is possible to organise face-to-face interaction at very short notice. Sometimes the need for geographical proximity can vary over the period of the interactions. This need may be intense in order to start the relationship and/or during the first phases of learning between actors who are innovating together: in this case it may be satisfied by the mobility of the actors in order to enable the face to face interactions which at certain moments remain essential. This need for temporary geographical proximity may be satisfied in various places: the company of course (meetings, technical platform teams) but also in temporary clusters (salons, conferences). TORRE (2008) thus insists on the importance of not confusing a need for geographical proximity with permanent co-location.

Secondly space constitutes a cognitive reference. All the participants live within groups situated in the same geographical space and associate values, perceptions, customs, lifestyles, a history, a name, physical and administrative boundaries, a memory of previous co-ordinated actions (successful or otherwise), conflicts, *etc.*, with a geographical area. Thus the place participates in the process of construction – or of destruction – of identities inasmuch as it is a component of the relationship to others since the local participants make it exist in the eyes of others. It is then at the origin of a sense of belonging: claiming to come from a particular place equates, by association, to claiming to come from a particular social group (GIDDENS, 1984). Space becomes a more or less important ingredient of collective action, inasmuch as it permits or inhibits coordination.

However, the fact of feeling geographically “close” should not be interpreted as an assurance that a relationship is necessarily established between the participants, even if it opens the way. It simply means that the existence of a strong geographical proximity between participants is not neutral: it makes the possibility of a relationship more likely, it is a resource that is still latent.

Geographical proximity only plays a role in terms of its articulation with a proximity of an organisational nature, which it supports, reinforces, compensates, or destroys by proving to be a source of conflicts.

### 1.2.2 Organisational proximity

Organisational proximity is deployed between individuals or between. It is built over a short social distance, in the same way as geographical proximity is built over a short physical distance. Social distance refers to the attributes of the participants in terms of cognitive and material resources, their age, their sex, *etc.*, in fact the whole set of objective criteria which allow us to classify individuals into more or less homogeneous groups. Social distance also

concerns organisations, for example companies in the same sector of activity which share the same markets, the same technologies, the same products, etc. This small social distance can take a more organisational form when two establishments adopt a similar structure: two research laboratories, two small firms or two subsidiaries of industrial groups have more or less identical constraints, objectives, interests, legal statuses which facilitate *a priori* the future mutual understanding necessary to the emergence of a relationship.

A small social distance is not sufficient to create an organisational proximity: thus two companies within the same industry may have no relationship apart from the simple, direct one of being competitors. In this sense, proximity is not simply the inverse of distance and cannot be reduced to simple similarity of characteristics. One is close to someone else when one not only resembles the other but when one shares various resources with him. One can speak of organisational proximity between organisations when they share, above and beyond a similarity in their legal structure, a language, perceptions, knowledge, know-how and a collective project signifying common strategic thinking as for example between two establishments of the same industrial group. When they are shared, these cognitive resources allow the acquisition, conservation and transmission of knowledge, know-how, experience, in other words to activate an inter-organisational relationship: in this way we move from a resemblance to a positive connection.

But the sharing of cognitive resources is not the only condition for the establishment of an inter-organisational relationship. When these resources take the form of moral values, social standards, rules or routines as between two public laboratories or two SMEs, they also act as regulatory tools for the relationship. In effect, it is necessary in addition to give coherence to contradictory interests, regulate conflicts which remain latent, prioritise problems, arbitrate, for example, the share of profits to which the parties aspire as a result of the interaction, or work out compromises. In other words, for a relationship to develop, it is necessary, alongside

cognitive resources, to share coordinated regulatory tools. Sharing of regulatory tools, desired or imposed, is the second condition for the establishment of an interaction. In reality, these tools, like rules, are most often indistinguishable from cognitive resources inasmuch as they fulfil both roles simultaneously.

### 1.3 Control by the two types of proximity

The link between control and proximity, particularly in terms of the analysis of the process of the emergence of innovations, has not yet been directly studied in the literature. The question posed in this part is the following: in terms of relationships, what is necessary to exercise control? Our response: proximity. We distinguish control by geographical proximity from control by organisational proximity.

#### 1.3.1 Control by geographical proximity

Participants can use two of the effects of geographical proximity to exercise their control. Firstly, face-to-face interaction is the occasion to improve the efficiency of formal control of productive relations because it allows, on the one hand, discussions to be interactive and, on the other, a reduction in the uncertainty leading from the tacit dimension inherent in all knowledge and in the risks of opportunism (BOSCHMA, 2005). In the same way, informal control, being based on mechanisms of shared standards, values, beliefs and trust, develops thanks to frequent meetings (LANGFIELD-SMITH and SMITH, 2003) made all the easier when the different parties are geographically close.

Secondly, geographical proximity indirectly favours informal control. It is known that social networks are often based in one locality. As GROSSETI and BES (2001) make clear, the creation and maintenance of social relationships pre-supposes frequent face-to-face interactions of a relatively routine nature which cannot be too dispersed. This explains why a

significant proportion of social networks are spatially concentrated. Now, certain economic relationships are *embedded* (GRANOVETTER, 1985) in these localised social networks, in the sense that the economic activity is dependent on the personal relationships between those who carry it out. Informal control benefits from this embedding: it is more difficult to adopt an opportunist strategy to the detriment of a neighbour with whom one shares the same social network. In a way, geographical proximity seals the relationship between agents who would have to pay in terms of their personal relationship any opportunist behaviour adopted in the economic sphere.

### 1.3.2 Control by organisational proximity

OUCHI (1979) lists a certain number of pre-requisites to the exercise of control: these include rules, values and beliefs defining adequate behaviour, a legitimate hierarchical structure into which everyone must fit: these constitute cognitive resources and regulatory tools which must be shared. In other words, in the same way that organisational proximity conditions the emergence and/or the reinforcement of a relationship in general, it conditions the effectiveness of inter-organisational control in particular.

More precisely, organisational proximity allows the setting up of formal control mechanisms. We have seen that the latter operate thanks to mechanisms which regulate behaviour (fixing of objectives, procedures, systems for monitoring and evaluating results and behaviour) thus making the relationship possible by securing it, each party being able to assure itself that the actions of its partners conform to its objectives and interests (NOGATCHEWSKY, 2003). Now, these mechanisms cannot exist unless the controllers and the controlled already have a minimum quantity of perceptions, knowledge and rules in common. In the same way, informal control is based on auto-regulatory mechanisms which require shared standards, values and beliefs (OUCHI, 1979), sharing which, for proximity authors, equates to the very

definition of organisational proximity. Moreover, organisational proximity creates trust towards others (DUPUY and TORRE, 2004) because of the similarities shown by close partners and because of the spirit of loyalty which can be generated by the fact of belonging to one and the same organisation: resemblance and belonging are sources of trust.

In the end, organisational proximity conditions control. It may possibly be reinforced by a geographical proximity between controllers and controlled. In return, as in any relationship, control will nourish proximities, *via* the mechanisms which are put into place, in a cumulative process. Thus the causal distinction made here between proximity and control is above all analytical, given the fact that it is so difficult in reality to separate out the causal links between the two concepts. To conclude this first section, the table below synthesises our vision of the concepts of proximity and of control, as well as the different mechanisms of control by proximity.

INSERT TABLE 1: Forms of control and proximity

In the following section, we test the way in which the parties to collaborative projects under the aegis of the Aerospace Valley cluster control their relationships using proximity. More precisely, we first examine whether informal and formal controls are practised by the same actors or if they are dispersed inside the cluster. Secondly, we look for the role of the two types of proximity in facilitating the two forms of control: can we observe any correlations between a form of proximity and a form of control?

## 2 Data and methodology: evaluation of the forms of control and proximity within the Aerospace Valley competitiveness cluster

### 2.1 The data: collaborative R&D projects in the Strategic Business Units of the Aerospace Valley cluster

As in other countries, French government policy concerning business and research clusters (*competitiveness clusters*) finds its roots in the notion of clusters (PORTER, 1998), which showed that permanent geographical proximity between participants, when it is desired, is a factor which favours the creation and the diffusion of knowledge. Indeed, in this way government policy aims to accentuate, through cluster-labelled mechanisms, the agglomeration of participants likely to innovate jointly, in the hope that geographical proximity, as a facilitator of face-to-face interactions, will play a beneficial role in terms of supporting organisational proximity. Since the launching of the policy in 2005, 71 clusters have been labelled as competitiveness clusters, including 14 world clusters. But, this policy has another aspect: it supports, through labelling mechanisms but also through public financial aid, collaborative R&D projects bringing together major firms, small and medium-sized businesses and research laboratories. The policy seeks to create progressively, as different interactions take place, a memory of successful cognitive coordination and policies and thus to build up trust between private and public organisations.

The AESE (Aeronautics, Space & On-board Systems) cluster, more often referred to as the “Aerospace Valley Cluster” is one of the world clusters created in 2005 in the Aquitaine and Midi-Pyrénées regions (in southwest France). In 2007, the cluster brought together 340 establishments and employed 64 421 people<sup>4</sup>. Unlike the majority of the clusters in France, this cluster is dominated by establishments controlled by industrial groups (203 establishments out of 340) and principally French groups (170 establishments), even if it does also include small and medium-sized firms and specialised research and training centres.

Despite being specialised in the aeronautical and space industries (48% of jobs), the Aerospace Valley cluster includes a wide spectrum of activities. The collaborative R&D projects undertaken in this cluster are in fact grouped into 9 Strategic Business Units (SBUs) representing the principal technological domains studied, from aeronautical activities to the design and production of satellites, and including embedded systems (cf. table 2 for details of the SBUs).

For several reasons, the aeronautical industry represents a field of observation which is relevant to our line of questioning. This cluster specialises in the aerospace industry has been chosen because of the strength of the control exercised by principals over contractors (KECHIDI and TALBOT, 2010; WINK, 2010), the former seeking to control the latter, whereas the latter aim to free themselves from the former. The strategies of externalisation developed by the aircraft manufacturers have led to the emergence of equipment manufacturers possessing specific skills: they are theoretically able to adopt opportunist behavior which calls for control. In addition to this strong asymmetry between the participants comes the question of joint innovation in a high technology industry: high R&D costs and the widening of the spectrum of skills necessary for the design of aircraft products encourage collaboration based on proximity (GILLY et al., 2011). Thus, whether it relates to the transfer of knowledge or to the sharing of results of joint innovation, the question of control by proximity becomes meaningful.

## 2.2 Methodology for the evaluation of proximity within SBUs

The methodology must allow us both to reveal the existing instances of proximity between the partners in collaborative projects within the SBU and to evaluate the control relationships which exist between them. In order to achieve this, the weight of organisational and geographical proximity is evaluated using simple statistical tools, whereas we use social

network analysis to reveal formal and informal control relationships. We can thus compare the 9 SBUs in terms of the weighting of the different forms of proximity and control exercised.

Following the methodology used for example by VICENTE *et al.*, 2010, in the sector of GNSS industry, we consider each SBU as a set of dyadic relationships between two establishments working together within the framework of a collaborative research project (cf. table 2). Indeed, even if all the participants in a single project have not the same degree of interaction, we could suppose that all the actors of a same project collaborate together even punctually. We propose to evaluate, using a binary variable equal to 0 or 1, the existence of different forms of proximity between two participants, then to calculate the mean and standard deviation of the number of dyadic relationships between two close participants within each of these SBUs<sup>5</sup>.

In order to evaluate organisational proximity, we have used three indicators which signify the sharing of cognitive resources and regulatory tools (*cf.* table A in the annex):

- organisational proximity varies in intensity depending on whether the two partners are members of the same organization (as industrial group) or not. We distinguish the case where dyadic relationships develop between two establishments from the same organisation and that in which such relationships develop between different organisations;
- two establishments share different statutes, legal and hierarchical rules, knowledge, know-how, values, collective projects depending on whether they are members of an industrial group or of a research laboratory. Here it is the organisational forms, revealing varying degrees of organisational proximity, which are different. Five organisational forms are distinguished: small and medium-sized firms (fewer than 200 employees), companies with 200 to 1000 employees, industrial groups of more than

1000 employees, public research laboratories and non-profit organisations. This indicator focuses in the first place on two similarities in character, legal structure and size: what is evaluated is thus the small social distance more than the organisational proximity in its entirety, even if the former is an essential component of the latter;

- operating in the same sector of activity pre-supposes sharing of cognitive resources such as technical knowledge, know-how and perceptions<sup>6</sup>. We thus propose in a third stage to differentiate the establishments of the cluster according to their sector of activity. In order to do this we have used the classification into 21 categories<sup>7</sup> derived from the nomenclature of the activities of French companies drawn up by INSEE: the French National Institute of Statistics and Economic Studies. First of all, the establishments of the cluster belong for the most part to 3 fields of activity. 88 companies specialise in industrial activities (“Manufacturing Industries” sector): this category brings together in particular the principal aeronautical architect-integrator and major suppliers. Next, 220 establishments belong to the “Specialised Scientific and Technical Activities” sector: these are public research laboratories, but also companies carrying out research and development activities and engineering activities. *Finally 39 establishments belong to the “Information and Communication” sector:* these are companies which carry out programming and information technology consulting.

Geographical proximity, as we have seen in the first part, is a judgment made about a small distance. If it is difficult to measure a judgment, the next best approach consists of integrating into the analysis the small geographical distance which separates the participants, considering that this is a necessary condition for the construction of a geographical proximity. A short geographical distance is considered here as signalling a possible geographical proximity: if face-to-face interactions are really facilitated in the case of a short geographical distance,

nothing indicates on the other hand that a strong sentiment of belonging to a group also exists from the fact of being associated with a place. This method allows us to take into account only one of the mechanisms of facilitation of relationships that is exercised by geographical proximity. In order to do this, we thus consider that two participants are all closer geographically when they are situated in the same urban area<sup>8</sup>.

### 2.3 A measure of control by the analysis of interaction networks

SBU's and collaborative projects are not exempt from control, on the contrary, it is necessary to control the way in which this knowledge is disseminated. Control also concerns the sharing of the results of the collaboration and in a general manner the way in which the interactions take place.

Network analysis offers a method of measuring control in the form of individual scores of centrality resulting from the position of the participant in the system of relationships (LAZEGA, 1994). These different measurements of the centrality of participants were in fact developed with the intention of measuring the relationships of power – and thus of control – within groups of individuals (DEGENNE and FORSE, 2004). This methodology is used, for example, in financial literature to measure the control exercised by board members through their places in the networks of boards of the major international groups (PICHARD-STAMFORD, 2000; BORGATTI and FOSTER, 2003; GUIEU and MESCHI, 2008). It is also used to measure potential organisational power viewed as a structural position (BRASS and BURKARDT, 1993).

In order to determine whether participants are in a position to exercise a form of control, we propose to construct networks of interactions and thus characterise their positions within each SBU. As is shown in figure 1 in the annex, we have constructed undirected networks: each establishment represents a node of the network and each link represents the common

participation in a collaborative project between two participants. Then, in order to measure the position of control of the different participants within this network, we use indicators of the position of the participants (in our case establishments) within the networks represented and more precisely the indicators of centrality. Two forms of centrality can be identified:

- degree centrality measures the number of links maintained by a participant in a network divided by the number of possible links<sup>9</sup>. A high indicator of degree centrality thus represents an above-average level of collaboration with all the other participants in the network. We have previously highlighted the fact that informal control takes place in particular by means of a mechanism of development of trust. We suppose that a participant who collaborates more strongly with all the other participants of the network will inspire more trust because, as we have already said, such trust emerges as a result of repeated, successful interactions. Moreover, the subject's multiple relationships allow him to disseminate the beliefs and values of the network and thus to exercise a social pressure allowing him to orientate behaviour in favour of the collective interest. He is thus in a better position than others to exercise an informal control. Degree centrality will thus be used as an indicator of the degree of informal control of a participant in the network;
- betweenness centrality is an index which allows one to measure the fact that a participant in the network is an intermediary between two other participants of the network<sup>10</sup>. Thus it is also a measure of informal control exercised by the participants of the network and more precisely of the control exercised by a participant on the relationships between the other participants. As before, a participant positioned between the other participants of the network will have been able to progressively establish trust, whereas this role of intermediary allows him to disseminate the beliefs and the values of the social group that makes up the network. Thus we use

betweenness centrality as a complementary indicator of the informal control exercised by a participant.

In order to compare the degree of control within each of the 9 SBUs, we have presented, in table 2, information on the mean of these different indicators of centrality within each SBU, as well as the maximum degree of centrality. Thus, just like other contributors to this special issue (BALLAND et al., 2013; BOUBA-OLGA and FERU, 2013), we have chosen to use the methodology of social networks to study the role of proximity in the interactions between actors in the innovation process. Nevertheless our approach stands apart from the rest of these contributions in the sense that we use this methodology as a measure of the control that one actor can exercise upon another<sup>11</sup>.

Within an SBU control can equally be exercised in a more formal manner through the management of the SBU. This management activity consists essentially of defining the objectives of collaborative projects and of verifying that they are consistent with the common strategy that prevails within the SBU. The definition of these objectives takes place during regular meetings. The institution of common rules in order to decide which sources of finance to apply for when seeking funds for a research project contributes to the development of a collective strategy. This management activity thus allows partial characterisation of formal control, previously defined as a form of control whose aim is to control results and behaviour by the definition of objectives, the setting up of standardized procedures, of schedules and of rules.

To summarise, we propose to compare, on the one hand, informal control evaluated through the central position in the active network (whatever means are used to calculate centrality) and, on the other hand, formal control *via* the management of the SBU. The result of this comparison is given in the following table and will be discussed in the following section.

INSERT TABLE 2: measurement of control and proximity within the SBUs of the Aerospace Valley cluster

### 3 Results and discussion

Tables 1 and figure 1 in the annex allow us to see different forms of dispersion of formal and informal control depending on the SBU. This leads us to propose a typology of the SBUs in four categories according to the form of control exercised. We will then study the weighting of the different forms of proximity within these four groups of SBUs.

#### 3.1 Intensity and dispersion of the forms of control within the SBUs

The first group is composed uniquely of the SE SBU. It is characterised by the fact that the formal and informal controls are exercised by the same dominant participants: two big industrial groups and a research laboratory of the University of Toulouse 3 which are at the same time managers of the SBU and present very high degrees of centrality within the network of participants of this same SBU. Here, the control is tight and concentrated on a few participants. Here we find an expression of control exercised by the aeronautical industry's prime manufacturers.

For the NPT, AMS and ATSS SBUs (group 2), a major aeronautical company undertakes both formal control (managing the SBU) and informal control (high degree of centrality). But the management of the SBU is equally undertaken by medium-sized companies or public research organisations which, at the same time, are only rarely included in the collaborative projects of the SBU: they thus exercise a control which is above all formal.

For the EPEE, ASOI and AI SBUs (group 3), one can again see that a major industrial company manages the SBU and occupies a central position in the network. One also notes, as in the previous group, companies or universities which exercise formal control dissociated

from any process of informal control. But these SBUs also include participants, mainly research organisations, situated in the centre of the network but which do not participate in the management activities of the SBU: in this last case, formal control is not accompanied by informal control. Thus in this group 3, control is tight but very dispersed and exercised by a great variety of participants. Moreover, informal control is more dispersed in this group of SBUs than in group 2 because it is sometimes exercised, outside the big industrial groups, by public research establishments.

Finally, two small SBUs – LES and MST (group 4) – show total dissociation between the indicators of formal control (management of the SBU) and informal control (centrality of the network). These SBUs bring together a small number of heterogeneous projects and do not appear to be established around a common strategy. It is notable that control is very dispersed. In particular, informal control is exercised by a great variety of participants and a strongly centralised network does not appear (*cf.* table B in the annex).

The following table synthesises our results by recalling the coordination mechanisms between formal control (management of the SBU) and informal control (centrality in the network) in the different groups of SBUs identified above. With respect to the theoretical discussion, we note that formal and informal control may, in certain cases, be dispersed among different actors, which justifies the distinction proposed in the first part between formal and informal control. We will now look for the role of proximity on this control.

INSERT TABLE 3: Intensity and dispersion of forms of control within the SBUs of the  
Aerospace Valley cluster

### 3.2 Proximity and control within the SBUs

The comparison between the groups of SBUs proposed in the preceding paragraph and the importance of the different forms of proximity does not reveal any correlation between the forms of proximity and the forms of control. Nevertheless, our results illustrate the existence of control by proximity. Table 3 shows different examples of SBUs which illustrate the four combinations presented in table 1. However a detailed analysis of the type of participants who exercise control within each group of SBUs associated with empirical, detailed knowledge resulting from the numerous interviews carried out allows us to shed some light on certain particular forms of control by proximity in the Aerospace Valley business and research cluster. We have obtained three types of results.

Firstly, our analysis of the different forms of control shows the existence, for the SBUs of groups 1 to 3, of a small number of big industrial companies exercising both formal and informal control (cf. third column of table 3). We thus note a concentration of control in the hands of characteristic participants. In fact, the relationships established within the framework of collaborative projects are embedded in two other types of relationship, reinforcing this control:

- on the one hand, the relationships relating to projects are embedded in localized social networks. These big industrial groups are practically all situated in Toulouse and thus share geographical proximity with the majority of the members of the Aerospace Valley cluster. Geographical proximity reinforces the formal control exercised in terms of the management of the SBU by facilitating meetings with these participants. It may also be noted that geographical proximity reinforces control not only inside the SBU, but also inside industrial groups, and particularly in the case of the ES SBU. For example, the number of links between establishments belonging to the same groups is significantly higher between establishments localised in the same area (31 links) than

between establishments which are distant from each other (12 links). This geographical proximity equally favours informal control through the establishment of informal meeting opportunities (for example during breakfasts organised between members of the cluster) which provide the occasion to develop the local social networks within which economic relationships are already embedded (the networks of former members of the prestigious Toulouse engineering schools specialised in aeronautics being very active). Thus informal control develops *via* localised social networks;

- on the other hand, recent relationships created by collaborative projects managed by the Aerospace Valley cluster are embedded in sub-contracting networks which are often long-established. These same big groups are the prime contractors of the aerospace industry and on this basis share an organisational proximity with industrial companies of different sizes (research laboratories are excluded in this case) forming part of the supply chain (KECHIDI and TALBOT, 2010; GILLY et al. 2011). In the supply chain the prime contractors exercise intense formal and informal control over suppliers of inferior rank. Collaborative projects thus associate companies which are otherwise clients or suppliers, i.e. controllers *vs* controlled: in this situation, the control mechanisms used within the framework of the supply chain and more generally the sharing of cognitive resources and regulatory tools (organisational proximity) have an influence on the controls exercised in collaborative projects. The control relationships which operate in the context of collaborative projects are dependent on the control relationships already operating elsewhere: the story of coordinations which have succeeded or failed, standards which have already been established, representations already shared, rules already imposed, fashion the interactions of today. Moreover, the context of a supply chain is not without effect: the asymmetrical positions of the parties involved mean that the sub-contracting SMEs

cannot escape from the control of the prime contractors without the risk of paying for such behaviour in their relationships outside collaborative projects. In such a situation this causality maybe reversed: according to our interviews, collaborative projects are sometimes seen by the prime contractors as a new opportunity to exercise an additional control over the skills, the know-how and the knowledge of their suppliers.

Secondly, groups 2 and 3 bring together establishments which exercise formal control by participating in the running of the SBU but which do not appear to exercise informal control (*cf.* fourth column of table 3). These are establishments which are geographically distant from the other members of these SBUs<sup>12</sup>. More precisely, while the majority of the participants in the AMS, NPT, ATSS and AI SBUs are situated in Toulouse and run by big Toulouse industrial groups, we note that formal control is exercised by establishments which this time are located in the Bordeaux region. These are public establishments (an engineering school in the case of the AI SBU), small companies (NPT SBU) or big industrial groups (ATSS and AMS SBUs): even if Bordeaux and Toulouse are only 220 km apart, geographical proximity could be stronger. On the other hand, the EPEE SBU, the majority of whose members are located around Bordeaux, is run jointly by a major Bordeaux group and a company located in the Toulouse region. It thus appears that formal control can be exercised in the context of weak geographical proximity. Even if geographical proximity could favour inter-organisational relationships as explained in the theoretical part (*cf.* table 1), this type of control is still based on contractual engagements and codified mechanisms which necessitate less geographical proximity. Nevertheless, tacit knowledge is often associated with individual people, the fact of being physically close will have a positive effect on the transfer of such knowledge (AUDRETSCH and FELDMAN, 1996), reinforcing the constraint of geographical proximity. This is true even if the technologies have evolved by facilitating the informal interactions necessary to the sharing of tacit knowledge and if the physical interaction does

not necessarily imply permanent proximity of the individuals (GROSSETI and BES, 2001; TORRE and RALLET, 2005). One can thus understand why we observe, in the last column of table 3, that informal control is exercised by public research establishments playing the role of intermediary<sup>13</sup>, establishments located for the most part near the other establishments of the SBUs. In our case, exercise of informal control necessitates stronger geographical proximity than formal control.

Thirdly and finally, as far as the articulation of the forms of proximity is concerned, it may be noted from table 2 that with the exception of the ES SBU, all the SBUs may be characterised by the fact that the two forms of proximity can be substituted for each other, at least in part. More precisely, participants who are geographically distant are generally closer from the point of view of their activities and vice-versa. Thus two SBUs, NPT and ATSS, are distinguished by a strong degree of geographical proximity between the participants, but a weaker degree of organisational proximity. For example, 19 of the 27 establishments of the ATSS SBU are located around Toulouse, but on the other hand these establishments (research laboratories, small and medium-sized businesses and major companies) are specialised in various domains around the theme of the safety and the security of air transport. For all the other SBUs, the participants are less geographically concentrated but share a strong organisational proximity. This is, for example, the case of the AI SBU, in which the participants are geographically dispersed notably in the Aquitaine (12 establishments out of 37) and Midi-Pyrénées (18 establishments out of 37) regions, but also throughout the rest of France. On the other hand these establishments (research laboratories and small and medium-sized businesses) are for the most part specialised in activities close to technical and scientific research. It thus appears that the closer the participants are from the point of view of their activities, the more easily they can develop spatially-dispersed relationships. The fact of sharing common knowledge bases, of being subject to identical technical constraints, of having representations which are

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relatively similar or which have even been co-developed during possible past interactions, of sharing rules of competition and financing particular to an industry, creates mutual understanding. This facilitates remote interactions and allows the removal of part of the constraint of geographical proximity that joint innovation may require. On the other hand, if the activities of the participants are relatively heterogeneous, frequent meetings will be necessary to remove the misunderstandings and ambiguities arising from different fields of activity. Finally, it should be noted that our results do not show that the substitution of geographical proximity for similar activities can be extended to the other two indicators of organisational proximity (belonging to the same organisation and organisational structure).

#### 4 Conclusion

Having proposed a typology for the Strategic Business Units of the Aerospace Valley cluster, depending on the intensity and the dispersion of the forms of control, several results have been updated. First of all, it has emerged, unsurprisingly, that formal and informal control is generally exercised by a small number of major industrial groups located near the majority of the establishments which are members of these SBUs and which are also the prime contractors in the supply chain. In this case collaborative R&D projects become new occasions for the deployment of the control relationships which already operate. Next, we have also been able to note that formal control based on formalised mechanisms does not require as much geographical proximity as informal control. Our results concerning the substitution noted between the forms of proximity have also confirmed the hypothesis according to which geographical proximity compensates for weak organisational proximity.

These results have consequences in terms of public policy. Thus, the public policy of competitiveness clusters seeks, in financing projects, seeks to encourage collaboration

between participants who are geographically close, heterogeneous in terms of organizational structure and complementary in terms of knowledge. This study shows that certain participants control the operation of the exchange and the achievement of the objectives, which allows the partners to feel secure and thus allows the exchange to take place. But hierarchies which are observed elsewhere are reproduced in collaborative projects. Thus, control has the disadvantage of reproducing existing a symmetrical modes of co-ordination which can inhibit collective innovation which calls for new combinations supposed to favour the evolution of established positions. From the point of view of public action, the key is to strike a balance between letting control become established in order to generate sufficient confidence and allowing relaxation of this same control in order to facilitate the emergence of new interactions, by their very nature less controllable.

More generally, this study has not enabled us to specifically analyse the role of local institutions in terms of the manner in which they take part in control: we have used a theoretical framework specific to companies which does not take into account the specificities of public bodies, for example in terms of their objectives of regional development. This question may, moreover, be extended to other types of organisation, such as research institutions for which objectives of production of public knowledge can come into conflict with the strong requirements of confidentiality of companies.

This study has other limitations. In theoretical terms, our study has not permitted the analysis of potentially negative effects (BOSCHMA, 2005; ZUINDEAU, 2006) that too great a proximity can have on control mechanisms. In effect, proximity can generate conflicts which can limit all forms of control. A possible development of our work would thus be to study the limiting role of conflicts on control mechanisms. Finally, analysing the role of proximity on the control of inter-firm relationships should lead us to question the efficiency of the control.

Without replying directly to this question, our results show that in the case observed, the

proximities are widely used in order to make the formal and informal control effective. Thus proximities and controls contribute to the existence and the durability of collaborative projects. It would probably be useful to tackle this question more directly in a future study linking proximities, controls and performances of collaborations, for example by following the methodology used by BENGTSSON and SOLVELL (2004).

Moreover, the intertemporal comparison of collaborative R&D projects within the same cluster would allow the introduction of dynamic elements into the analysis in order to observe the evolution of control relationships by proximity. In terms of methodology, other measures of control are possible. In particular, formal control could be measured through a study of the research contracts drawn up by the members of collaborative projects. Such a study would consist of analysing the degree of formalisation of the role of each of the participants in the collaborative projects, both in terms of the operation of exchanges during the research process and of the sharing of intellectual property of the results of the research. We could also include a more qualitative analysis of the objectives of the projects in order to see if the forms of control by proximity are different between theoretical and applied projects, but also between projects with different degrees of uncertainty or risk. In empirical terms, the choice of an industry in which the major groups occupy a predominant place led us to analyse relationships in which control was concentrated. Finally, this study should be extended to new activities in which control is more dispersed (mechanical engineering, photonics, *etc.*), by looking at other competitiveness clusters which are orientated towards innovation, but also by offering an analysis of control by proximity, this time between establishments collaborating in several competitiveness clusters.

## ANNEXES

INSERT FIGURE 1 : networks of collaborative projects in the SBUs of the Aerospace Valley cluster

Notes:

1. The French public policy towards competitiveness clusters will be presented in paragraph 2.1.
2. More generally, for a critical review of the literature on research into *Management Control Systems*, cf. CHENHALL (2003).
3. Trust is used here with both of its usual meanings (DUPUY and TORRE, 2004): trust towards another and trust in the fact that ones' expectations will be met in the future.
4. This figure, like all the figures presented in this introductory paragraph on the Aerospace Valley, is taken from the Aerospace Valley competitiveness cluster performance indicators published by the Inter-ministerial Delegation for Regional Planning and Competitiveness in 2009 and available on competitiveness clusters Internet site:  
  
[http://competitivite.gouv.fr/documents/commun/Les\\_Poles\\_en\\_mouvement/Poles\\_de\\_competitivite\\_mondiaux/tableaux-bord-statistiques/Aerospace\\_Valley\\_7123.pdf](http://competitivite.gouv.fr/documents/commun/Les_Poles_en_mouvement/Poles_de_competitivite_mondiaux/tableaux-bord-statistiques/Aerospace_Valley_7123.pdf)
5. In the case where two establishments work together within the framework of several collaborative projects but within the same SBU, we consider these relationships to be different and they are thus counted separately for the calculation of the weighting of the different forms of proximity and of the density of the network.
6. Cf. (FRIGANT and TALBOT 2005) more detail on the content of these perceptions in the aerospace industry.
7. For more details concerning these categories, see:  
  
<http://www.insee.fr/fr/methodes/default.asp?page=nomenclatures/naf2008/naf2008.htm>.
8. An urban area is defined as “*a group of communes, geographically contiguous and without any enclaves, consisting of an urban centre with more than 10,000 jobs, and of rural communes or urban units (peri-urban zone) of which at least 40 % of the resident working population works in the urban centre or in communes attracted by it*” (INSEE, 2011 :

<http://www.insee.fr/fr/methodes/default.asp?page=definitions/aire-urbaine.htm>). We have also verified that two organisations situated in two different urban areas are not situated in urban areas which have a common border (in which case they could be considered as being geographically close).

9. Centrality of degree is defined as:  $C_d(i) = \frac{d(i)}{n-1}$ , where  $d(i)$  represents the degree, i.e. the number of links of an individual  $i$  in the network, and  $n$  the number of individuals in the network.

10. Betweenness centrality is defined as:  $C_b(i) = \frac{2}{(n-1)(n-2)} \sum_{j=1}^n \sum_{h=1}^n \frac{n_{jh(i)}}{n_{jh}}$ , where  $n_{jh}$  is the number of geodesics linking the individuals  $j$  and  $h$  and  $n_{jh(i)}$  the number of geodesics (minimum links) linking the individuals  $j$  and  $h$  involving the individual  $i$ , with  $i \neq j \neq h$ .

11. This methodology for measuring the two forms of control – formal and informal – as well as the information that we present afterwards concerning the management of the SBUS has been validated through interviews. These interviews were carried out between September 2008 and February 2010 as part of a research contract co-financed by the Aquitaine and Midi-Pyrénées Regions whose aim was to analyse organisational changes in the regional aerospace supply chain. In total, 38 interviews were carried out with companies, research laboratories and local authorities which support innovation. Carried out in a semi-directive fashion, these interviews were done with people who are responsible for different SBUs. These interviewees were generally senior managers from major groups (Airbus, Thales, Safran) made available for the occasion. These interviews provided the opportunity to collect concrete data concerning formal control. We thus sought to understand what were the formal control mechanisms set up (objectives, procedures, schedule, rules for evaluation) by these senior managers. Beyond the description of the tools, interviewing offers the advantage of being able to evaluate, by comparison and cross-referencing of the information collected, the

effectiveness and the intensity of their use. Fuller information concerning these results has been given in another study (GILLY et al. 2011).

12. With the exception of the ASOI SBU which is highly specialised in the space industry, which is itself historically highly concentrated on Toulouse. *Cf.* DUPUY and GILLY (1999) on this last point.

13. *Cf.* VICENTE *et al.*(2010) for similar results in the GNSS (Global Navigation Satellite Systems) industry.

## Acknowledgement:

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TABLE 1: Forms of control and proximity

			Formal control	Informal control
		Role of control	Control results and behaviour	Control behaviour by auto-regulation
	Role of proximity	Control mechanisms Proximity effects	- Joint statement of objectives ( <i>ex-ante</i> ) - standardised procedures, schedule, rules ( <i>ex-ante</i> ) - Evaluation systems ( <i>ex-post</i> )	- Development of trust - Sharing of standards, values and beliefs
Geographical proximity	Favours inter-organisational relationships	- Face-to-face - Sentiment of belonging to a group by association with a place	Geographical proximity reinforces formal control by facilitating face-to-face interactions	Geographical proximity reinforces informal control because social networks are often geographically localised
Organisational proximity	Conditions inter-organisational relationships	Sharing of cognitive resources and regulatory tools	Organisational proximity conditions the setting up of regulatory mechanisms for behaviour	Organisational proximity conditions the setting up of auto-regulatory mechanisms for behaviour and creates trust

Source: authors.

TABLE 2: measurement of control and proximity within the SBUs of the Aerospace Valley cluster

Themes	N°. participants	N°. projects	N°. links (density)	Informal control: Degree centrality (mean/maximum)	Informal control: betweenness centrality (mean/maximum)	Formal control: Running of SBU	Similarity formal and informal control	Geo. Proxi.	Orga. Proxi manager/group	Orga. Proxi structure	Orga. Proxi activity
Embedded systems (ES)	111	27	884 (7.24%)	2.11 (13.90*)	1.14 (22.11*)	3	+++ (group 1)	34.73% (0.48)	2.38% (0.15)	29.30% (0.45)	39.71% (0.49)
Aero-mechanics, materials and structures (AMS)	131	21	1628 (9.55%)	3.25 (13.59)	0.91 (28.83)	3	++/- (group 2)	14.68% (0.35)	2.52% (0.16)	30.96% (0.46)	43.55% (0.50)
Navigation, positioning and telecommunications (NPT)	69	16	399 (8.50)%	4.25 (26.10 )	1.42 (37.57)	4 (1)	++/- (group 2)	49.62% (0.50)	0.50% (0.07)	29.57% (0.46)	36.34% (0.48)
Air transport safety and security (ATSS)	27	5	129 (17.06%)	12.25 (35.90)	0.04 (0.11)	2	++/- (group 2)	58.14% (0.49)	6.20% (0.24)	22.48% (0.42)	32.56% (0.47)
Access to space and orbital infrastructures	16	4	48 (20%)	27.50 (53.33)	0.71 (11.43)	2	+/- (group 3)	12.50% (0.33)	6.25% (0.24)	39.58% (0.49)	58.33% (0.50)

(ASOI)											
Architecture and Integration (AI)	36	5	190 (15.08%)	30.93 (61.11*)	3.18 (41.27*)	2	+/- (group 3)	23.68% (0.43)	2.63% (0.16)	34.74% (0.48)	57.89% (0.49)
Energy, propulsion systems, engines, environment (EPEE)	33	7	122 (11.55%)	11.55 (32.81)	3.56 (54.23)	2 (1)	+/- (group 3)	15.58% (0.36)	1.64% (0.13)	31.15% (0.46)	43.44% (0.48)
Maintenance, services and training (MST)	17	3	66 (25.89%)	24.26 (40.62**)	0.49 (2.08**)	2 (1)	--- (group 4)	6.06% (0.24)	0%***	21.21% (0.41)	57.58% (0.49)
Living Earth and space (LES)	25	4	86 (14.33%)	28.67 (54.17)	2.43 (32.61)	4 (3)	--- (group 4)	32.56% (0.47)	0%***	25.58% (0.44)	61.63% (0.49)

Source: authors, following the description of the collaborative projects of the Aerospace Valley cluster in June 2009.

Legend: The first three columns of the table give information on the overall structure of each SBU: the themes of each SBU, the number of establishments which are members of each SBU, as well as the number of collaborative projects belonging to each SBU. The next column gives the number of dyadic links analysed in terms of this network as well as, in brackets, information on the density of the network, i.e. the number of links divided by the number of possible links. The next two columns allow the evaluation of the weight of the informal control through measures of centrality of the two networks. For each of the two forms de centrality (degree, betweenness), we indicate the mean degree of centrality of all the participants in the SBU, as well as the maximum degree of centrality. The next column allows the evaluation of the weight of formal control by representing the number of establishments leader of the SBU and, in brackets, the number of establishments leader which do not participate in a single collaborative project of this SBU. The next column refers to situations where formal and informal control are cumulative: the + (and, in the negative sense, the -) represent the greater or lesser

degrees of similarity between the coordinators of the SBU and the central participants of the networks. The last four columns give information about the weight of the different forms of proximity within each of these SBUs. For each form of proximity, we indicate the mean number (with the standard deviation in brackets) of relationships (in the sense of a joint collaborative project between two establishments) for which the participants are considered as being close.

NB:

\* In the AI and ES SBUs, unlike all the other SBUs, the same establishments do not have the highest levels of degree and betweenness centrality. In the case of the AI SBU, two research establishments show the highest levels of degree centrality and betweenness centrality. In the case of the ES SBU, it is a major aeronautical group located in Toulouse which has the highest level of degree centrality and a university laboratory which has the highest level of betweenness centrality. And despite this dispersion, the levels of centrality of these four participants remain very high for the two SBUs.

\*\* In the MST SBU, four companies of equivalent size show maximum (and equal) levels of centrality (according to the three forms of calculation). Thus these companies share the informal control of this SBU.

\*\*\* The value 0 in the case of organisational proximity in terms of belonging to a group or an university or public research organism indicates that, in the MST and LES SBUs, each participant belongs to a distinct group or university or public research organism.

TABLE 3: Intensity and dispersion of forms of control within the SBUs of the Aerospace

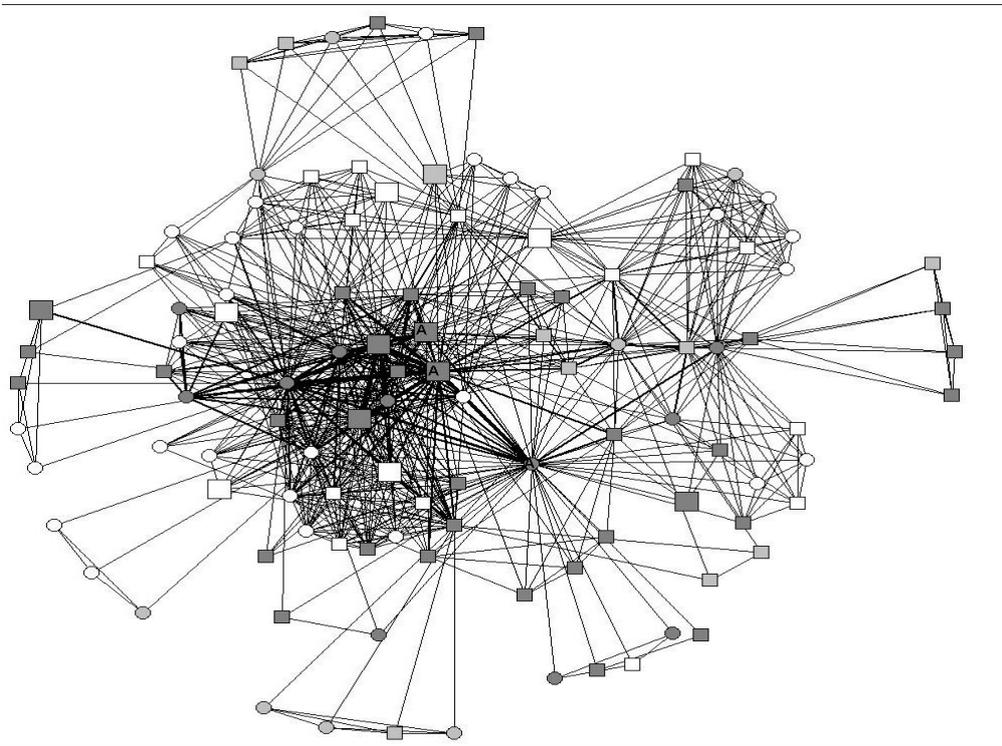
Valley cluster

	Degree of intensity and dispersion of control	Simultaneous formal and informal control, exercised by one (or several) participant(s)	Formal control exercised par one (or several) participant(s) who do not exercise simultaneous informal control	Informal control exercised par one (or several) participant(s) who do not exercise simultaneous formal control
Group 1: SBU ES	Control tight and concentrated	Major industrial groups and a research laboratory	/	/
Group 2: SBU AMS, NPT and ATSS	Control fairly tight and fairly concentrated	Major industrial groups	Various establishments (depending on the SBU)	/
Group 3: SBU AI, EPEE and ASOI	Control tight but dispersed	Major industrial groups	Various establishments (depending on the SBU)	Public research establishments
Group 4: SBU MST and LVE	Control slack and dispersed	/	Various establishments (depending on the SBU)	/

Source: authors.

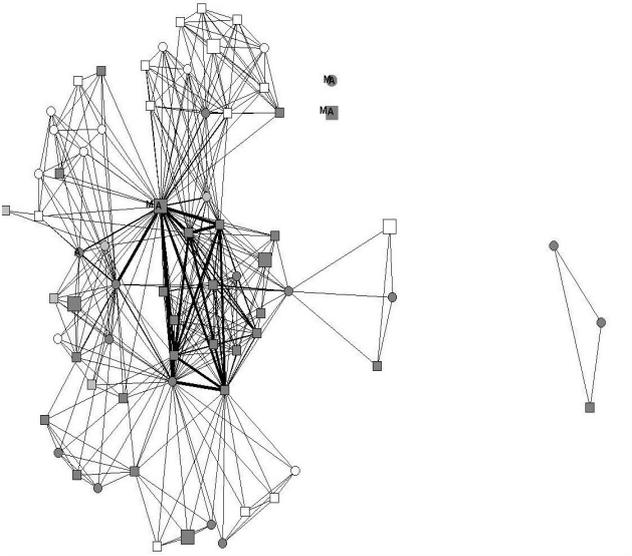
FIGURE 1 : networks of collaborative projects in the SBUs of the Aerospace Valley cluster

Group 1 : The ES SBU

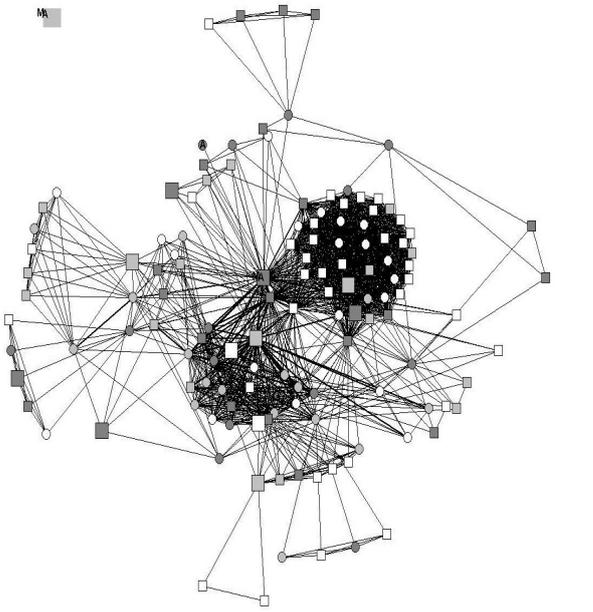


Group 2

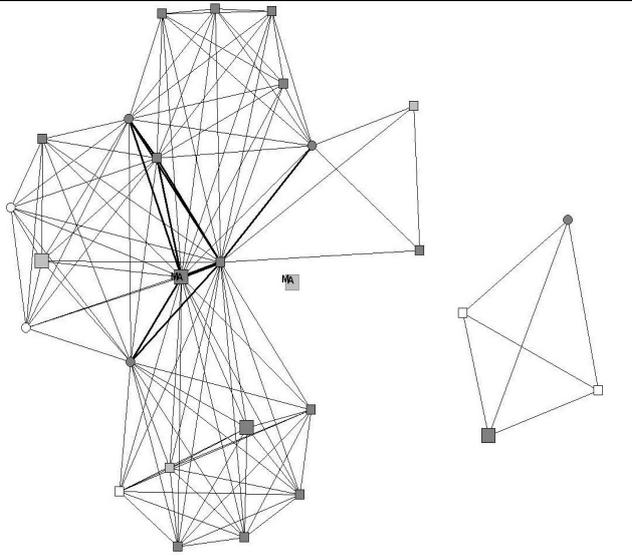
The NPT SBU



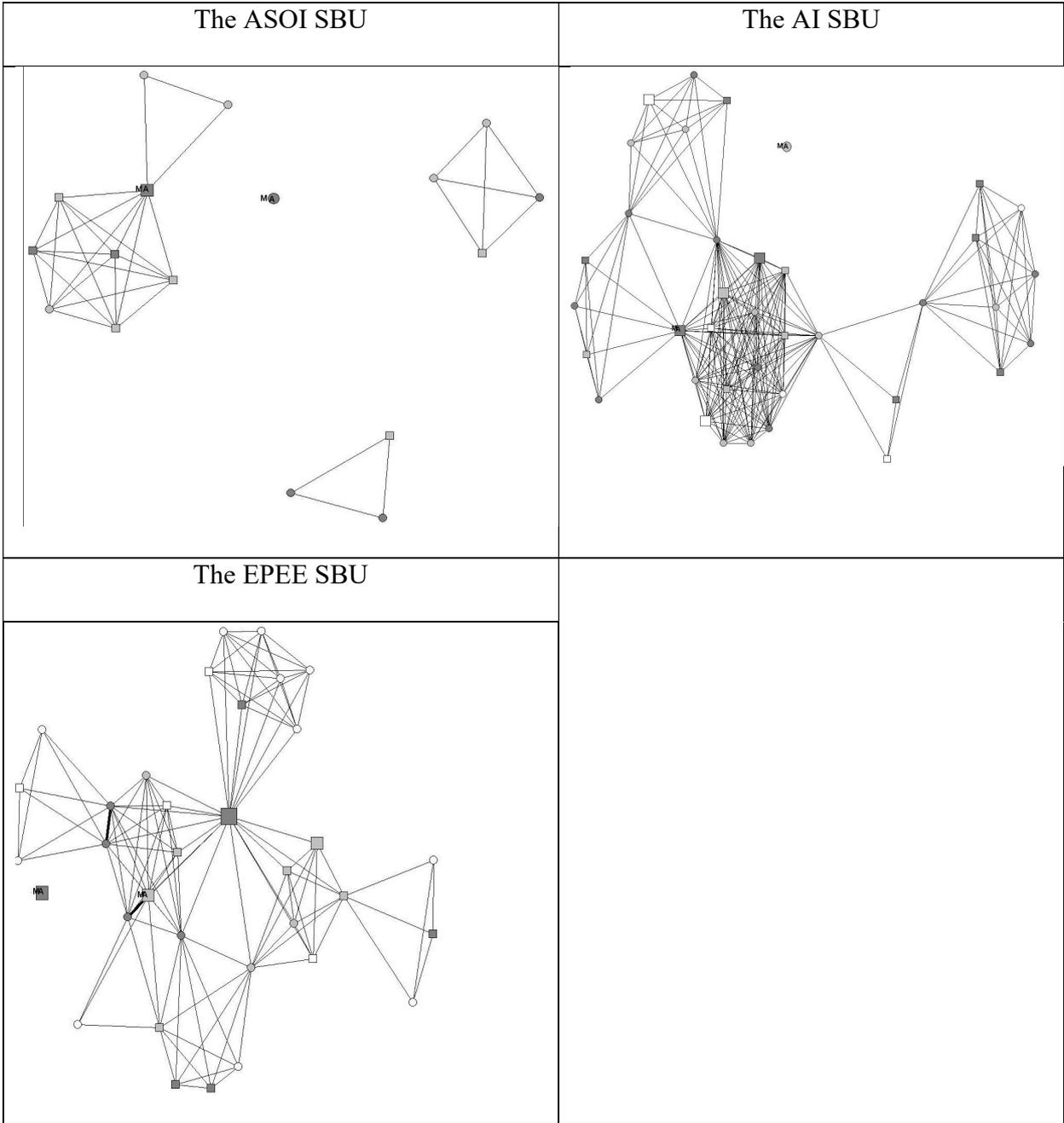
The AMS SBU



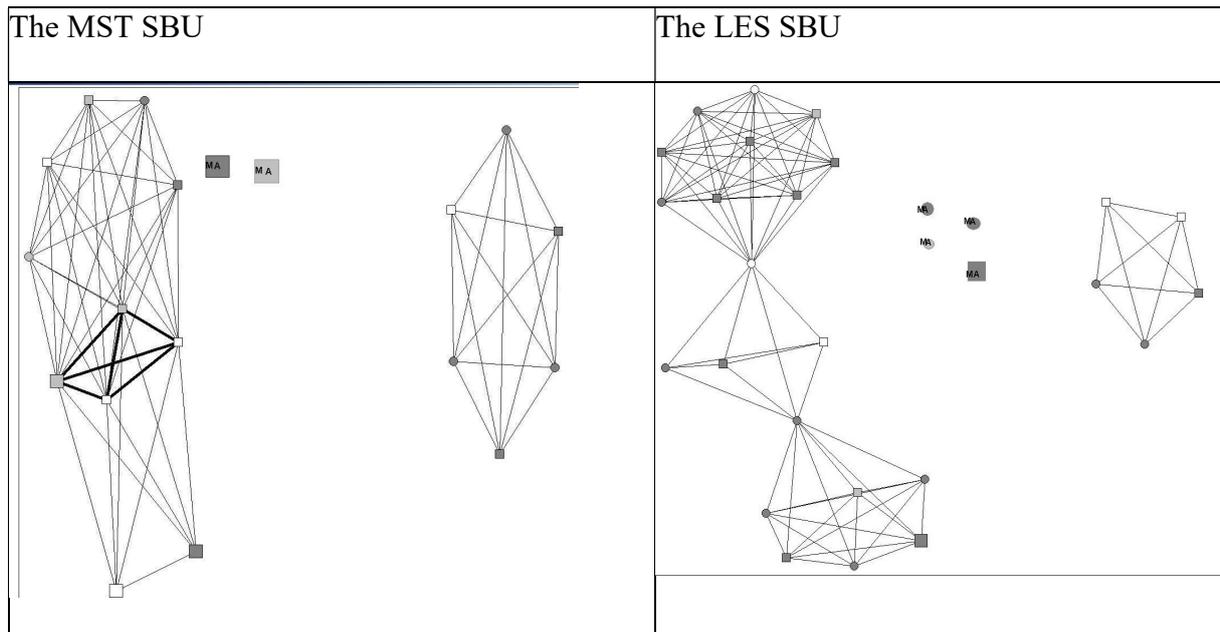
The ATSS SBU



Group 3



## Group 4



Source: authors, following the description of the collaborative projects of the Aerospace Valley cluster in June 2009.

Legend: Each node in the network represents an establishment and each line represents joint participation in at least one collaborative project of an SBU.

The thickness of the lines is proportional to the numbers of collaborative projects involving the two participants.

The colour and the shape of the nodes characterises the establishments which are members of this SBU. Establishments located in Midi Pyrénées (around Toulouse) are shown in dark grey, establishments located in Aquitaine (around Bordeaux or Pau) are shown in pale grey and establishments located throughout the rest of France are shown in white. Circles represent research laboratories, and squares represent companies. The size of the squares is proportional to the size of the companies.

The nodes with an M in the centre are the establishments which manage the SBU.