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Proximity relations and firms innovative behaviours

Different proximities in the optics cluster of the greater Paris region

André TORRE

UMR SAD-APT, INRA, Agro Paristech
16, rue Claude Bernard
F. 75231 Paris Cedex 05
E-mail: torre@agroparistech.fr

Sofiène LOURIMI

French Ministry of Industry
General Directorate for competitiveness, industry and services
Immeuble Bervil, 12, rue Villiot
F. 75572 Paris Cedex 12
E-mail : slourimi@yahoo.fr

Abstract

Analysis of proximity relations has often focused on the areas of industrial relations and innovation, introducing successive refinements centred around various concepts of proximity. The aim of this article is to assess for the respective role of spatial and non-spatial proximity relations, and local and long-distance links in innovative firms behaviours, using a representative case study. We want to explore the different proximity relations maintained by various types of innovative firms in a cluster, using an applied example, the one of the optics cluster in the greater Paris region. In order to identify groups of firms we apply the Porterian analysis method to strategic groups. The results reveal the existence of four different groups of innovative firms that maintain specific spatial relations and mobilize local relations and long-distance exchanges in different ways, via mobility or ICT. Small innovative firms are more constrained to permanent location, and the mobilization patterns of the different proximity types vary depending on the size of the firms, their place within the value chain, their degree of specialization and the maturity of the technology used.

Keywords: proximity, innovation, strategic interaction, local relations, mobility, long-distance exchanges

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Introduction

There have been some important developments in the analysis of proximity relations since its origin. First introduced by a group of French economists (Kirat & Lung, 1997; Torre & Gilly, 1999), during the 1990s this approach was primarily confined to the analysis of industrial production relations and was specifically developed in the context of the study of innovation processes. Industrial relations, innovation, firm mobility, new technology, territorial resources, local productive systems... all have been studied, endlessly explored and brought back under the spotlight again by the confrontation between theoretical analysis and empirical research (Boschma, 2005, Carrincazeaux et al., 2008, Rychen & Zimmermann, 2008).

This analytical movement has broadened and has thematic and disciplinary extensions. However the interest in innovation processes has remained at the crux of proximity relations analysis (Baptista & Mendonça 2009; Gallie 2009). Research has focused specifically on the study of inter-firm collaborative and cooperative relations, predominantly at a local level but also between firms and their environment (Dankbaar 2007; Wetterings & Boschma, 2009), under the influence of works focusing on local networks and global pipelines in the process of knowledge creation (Bathelt et al., 2004; Vaz & Nijkamp, 2009). Changes in innovation and research are made from an evolutionary perspective; they are considered to be collective processes and are repositioned in their spatial and organizational context (Freel, 2003; Laursen et al., 2010; Ponds et al., 2007). The role of geographical proximity in the spatial agglomeration of firms is highlighted (Takeda et al. 2008), as well as processes of local learning or transmission of innovation and knowledge through face to face channels (Giuliani & Bell, 2005).

But, during the same period, approaches to proximity moved away from the restrictive framework of clusters and local relations to focus more on long-distance relations and their spatial connection. Proximity analyses emphasized the non-local or non-regional links of clustered firms and their crucial role in terms of innovative behaviours and competitiveness of local systems (Weterings & Ponds, 2008; Biggiero & Sammarra, 2010) as well as long-distance collaboration and exchanges using ICT or mobility of engineers and researchers between professional locations or to fairs and trade shows (Bathelt & Schuldt, 2010). Today, this approach also relies on the study of concepts such as Temporary Geographical Proximity or of long-distance Organized Proximity relations (Freire-Gibb & Lorentzen, 2011; Torre, 2008) and their influence on the behaviour of innovative firms and local organisations.

The aim of this article is to assess for the respective role of local and long-distance relations, and spatial and non-spatial proximity relations in firms innovation behaviours. We want to explore the different proximity relations maintained by innovative firms in a cluster, using an applied example. The goal is 1) to confirm the combination of internal and external links of clustered firms, 2) to clarify the respective combination or exclusion of Geographical and Organised Proximities, 3) to investigate the role played by Temporary Geographical Proximity in clustered innovation processes.

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First, we shall present the different proximity relations and their connection to innovation processes by examining the two main concepts of proximity (Geographical and Organised), identifying their role within the clusters, and then reviewing the importance of Temporary Geographical Proximity relations. We shall then discuss the case study, the optics sector in the greater Paris region. We shall begin by justifying the choice of sector - representative of both innovative relations at a local level and strong external pipelines - before presenting the characteristics of the different strategic groups of firms within the cluster and the distinct relations they hold with the various proximity categories. We shall then show that the proximity approach allows for a better understanding of the network strategies and the innovation behaviours of innovative clustered firms with regards to their peculiar specificities (especially size and technological levels).

I. Proximity and Innovation

In this paper, the analysis of the role and position of proximity relations in innovation processes is based on the definition of two broad categories of proximity, that we shall define as Geographical Proximity and Organized Proximity, respectively (see Torre, 2008, Torre & Rallet, 2005). The more or less successful conjunction or combination of the two proximity categories elucidates the relationship between firms in relation to collaboration or exchanges at a local level during research and development processes, and allows the level of interest in co-location for specific innovative activities to be measured. However, approaches in relation to Temporary Geographical Proximity should also be included in this analysis, to cater for the study of long-distance collaboration on projects and to measure the respective advantages of long-distance or local collaboration in terms of innovation flow.

I.1. The notions of proximity

A recent tradition the field of Proximity analysis identifies two main streams of research; several authors (Boschma, 2005) identify four or five main types of proximities, usually quoted as geographical, social, cognitive, organisational or institutional ones. In contrast, in keeping with our previous works, we maintain the distinction between two main categories of proximity: Geographical Proximity and Organized Proximity, which encompasses various types of non-spatial proximity (Torre, 2011; Torre & Rallet, 2005; RERU 2008) [1]. It is activation through human action that gives this potential its significance and value ("positive" or "negative") in relation to the economic and social criteria that are relevant in the societies where it is found. The activation of the proximity types gives rise to different forms of spatial relations, and especially to different types of relations and collaboration between firms, whether located within the clusters or at a distance.

[1] Different notions of proximity, like relational, cognitive or institutional proximities are referred in the literature. As we will show after these notions are encapsuled in our generic two notions of geographical and organised proximities, which offer also a simplified and more straightforward framework of analysis.

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The notions of proximity refer, above all, to potentialities given to individuals, groups, human actions in general, in their technical and institutional dimensions. This potential may, or may not exist at a time t, and therefore may or may not be usable or actionable through the action and representations of the actors (human or non human).

Geographical Proximity

Geographical Proximity is above all about distance. In its simplest definition, it is the number of meters or kilometres that separate two entities. But it is relative in three ways:

- In terms of the morphological characteristics of the spaces in which activities take place. There can be a « crow flies » proximity, in the case of a trip by plane for example, but the nature of the terrain also plays a role: travelling from one point to another on a flat surface is not equivalent to climbing up and down a mountain in order to go from a point A to a point B ;
- In terms of the availability of transport infrastructure. The existence of a road or a highway, of a railway or metro network, of river-borne transport, will make access to a place more or less quick and more or less easy ;
- In terms of the financial resources of the individuals who use these transports infrastructures. A high speed railway line might enable people to travel more quickly to and from two places, but its cost proves prohibitive for part of the population, at least in cases when the individuals have to travel frequently. Therefore we shall say that the Geographical Proximity between two people, or between people and places, is partly related to the cost of transport, and to the financial means of individuals.

Geographical Proximity is neutral in essence. It is the way in which actors use it that matters. Thus, the fact that two firms are located in proximity of each other may or may not be a source of interaction: these two entities may remain indifferent to each other or they may choose to interact; in this latter case we talk of a mobilization of the potentialities of Geographical Proximity. But this mobilization can have different results depending on the actions undertaken. For example, in the case of innovating firms, it might be the diffusion of scientific or technological knowledge through geographical spillover effect (Bonte 2008) but it might also lead to firms spying on other firms, or unduly reaping the benefits of an invention that is supposed to be protected by intellectual property rights (Boschma 2005; Arend 2009).

Organized Proximity

Organized Proximity too is a potential that can be activated or mobilized. Organized Proximity refers to the different ways of being close to other actors, regardless of the degree of Geographical Proximity between individuals, the qualifier « organized » referring to the arranged nature of human activities (and not to the fact that one may belong to any organization in

particular[2]). Organized Proximity rests on two main logics, which do not necessarily contradict each other, and which we shall call the «*logic of belonging"* and the *"logic of similarity".* Both can help in the setting of trust relations.

The logic of belonging refers to the fact that two or several actors belong to the same relationship graph, or even to the same social network whether their relation is direct or intermediated. It can be measured in terms of degrees of connectivity, reflecting more or less high degrees of Organized Proximity and therefore a more or less great potential of interaction or common action. The development of interaction between two actors will be facilitated by their belonging to the same tennis club, or Internet knowledge network. Similarly, cooperation will, *a priori*, develop more easily between researchers and engineers who belong to the same firm, the same technological consortium or innovation network. It includes common organizational culture between the members of a team for example.

The logic of similarity possesses two facets. It can develop within a reciprocal relationship; a relationship which shortens the cognitive distance between the actors involved (common project, common education, knowledge circulating within a network...), but it can also emerge from a common basis, facilitating the communication between strangers (see the example of diasporas). The actors linked by a logic of similarity share certain resources, of a material (diplomas or social status) or cognitive (routines, conventions...) nature, which can be mobilized when the properties described here are activated.

Just like Geographical Proximity, Organized Proximity refers to a potential that is neutral in essence. It is the perceptions and actions of individuals that give it a more or less positive or negative dimension, and therefore a certain usefulness. Thus, being connected by a logic of belonging is not a guarantee that interactions will occur, and even less a guarantee of the quality of these interactions. It is human actions that determine whether or not actors are going to start interacting, just like the circulation of electricity through a wire. And results of the interactions vary in this regard: a firm may enter into a relationship with a laboratory in order to collaborate with the latter, or rather to try and rob the laboratory of one of its inventions. For the logic of similarity, the power already exists but it needs connection. With regards to the results of interaction, a common project has as much chance to lead to an industrial or technological success as to end up in a failure resulting in heavy losses for the parties involved.

I.2. The role played by Proximity within clusters

Several applied works have been devoted to the study of proximity relations within clusters (see Biggiero & Sammarra, 2010; Carrincazeaux et al., 2008; Takeda et al. 2008; Weterings & Ponds, 2008). Following on from the definition of the notions of proximity, we shall proceed to analyse the interaction of the different Proximity types and explore further the manner in which they contribute to relations between economic and social actors. The combination of

[2] One may be organized or one may organize an activity without necessarily referring to or belong to an organization, in the strict sense of the term.

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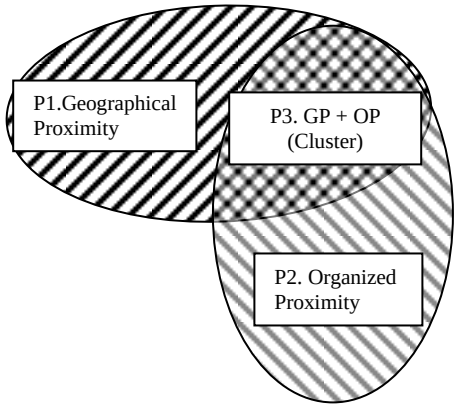
Geographical and Organized Proximity provides some understanding of the coordination and communication process between actors, both local and remote, based on the following hypotheses.

- *P1. The potential of Geographical Proximity can remain inactive, or not mobilized.* Two people or two firms can find themselves in a situation of Geographical Proximity without interacting with one another. A laboratory can be located in Proximity to a firm with which it has no connection.
- *P2. The potential of Organized Proximity can remain inactive.* This is the case for people of the same geographical origin or who come from very similar cultures but who do not meet or communicate with one another. Organized Proximity remains a potential state and is only activated by the establishment of interaction based on the actions of groups of individuals or institutions.
- *P3. The simultaneous mobilization of the two types of Proximity gives rise to situations of localized coordination.* This is the case of "working" clusters, local innovation networks or family gatherings, situations where the combination of Geographical and Organized Proximity promotes the establishment of coordination and interaction processes taking place in a specific location.

It is possible to infer that the two categories of Proximity (Geographical and Organized Proximity) can either evolve separately or together, as shown in Figure 1.



The combination of both types of Proximity corresponds to a situation where the Potential of Geographical Proximity is permanently activated through interaction with Organized Proximity. This situation is particularly significant for clusters or local production and innovation systems (of which schools are often cited as an example), which are one of the combinations in the articulation of the two broad categories of Proximity. It should be noted that this combination is difficult to achieve as it requires the co-location of the actors involved, the mobilization of which often depends on the existence of appropriate policies.

Figure 1: The articulation of the two major categories of Proximity within a cluster

The intersection of the two categories of proximity provides an analysis framework for the different models of geographical organization of activities. In the "winning" clusters, not only are the firms located in the same place (Geographical Proximity) but they also are closely linked and maintain privileged relationships with one another (Organized Proximity), in terms of the technology exchange and knowledge transfer. This is the ideal situation, one which every local decision-maker dreams of creating within their sphere of influence.

Although widely discussed in economic literature, this model is only one possibility among others in the interaction of proximity types, and is not that commonly observed in reality. Indeed, Organized Proximity - consisting of functional relations (interaction) or relations between people sharing the same identity (common beliefs and cognitive maps) based on organization rather than territory - often exists independently of Geographical Proximity. Similarly, firms may find themselves in Geographical Proximity of one another without maintaining any organized relations. In this situation Geographical is permanent in nature. Firms or laboratories are located on the same site and therefore at short distances from one another. Furthermore, these entities have formed relations of Organized Proximity, such as client-supplier relationships, exchanges of know-how or various kinds of cooperation.

This alchemy, albeit exceptional, is based on the activation of Geographical Proximity by organizational and institutional actions. In other words, in order to reveal the full potential of Geographical Proximity, it is necessary to mobilize the logic of belonging or the logic of similarity of Organized Proximity:

- from an organizational point of view, this requires collective action at a local level, and more importantly the establishment of common projects. These projects may consist of collaboration between different firms or laboratories for the co-development of products or for the provision of technical support or mutual assistance within the same group; or also of cooperation projects jointly undertaken by firms or research laboratories. Local skills and knowledge are combined to work towards a common goal shared by a group of co-located participants. It is in this context that the potential benefits of Geographical Proximity can be realized and contribute to the creation of synergy within the local system;
- but the institutional dimension and the role played by history and time in the mobilization of the potential benefits of Geographical Proximity must not be underestimated. Just as the examples of the Hshinsu Technopole in Taiwan or Sophia Antipolis (Lazaric et al. 2008) have shown, the creation of synergy within a local system is based on the development of shared representations or expectations by local actors: it can be said that Geographical Proximity is activated by the mobilization of the logic of similarity associated with Organized Proximity. Furthermore, time favours the creation of a local innovation network and the transition from the juxtaposition of R&D activities to a system characterized by organized relations, by the creation of a sense of belonging and common representations, through successive confidence-producing interactions.

I.3. Introducing Temporary Geographical Proximity

Taking into account long-distance relations rests on the explicit integration of the processes of mobility and ubiquity of actors. The multiplication and ever-increasing technological level of land and aerial transport infrastructures, has now combined with the revolution of ICT. All have led to significant modifications in actors' relations to space and to the development of new relations between economic and social actors (Torre & Rallet 2005).

Mobility and ubiquity condition long-distance relations

The phenomenon of mobility is related to Geographical Proximity. The increasing mobility of people enables individuals to act in different places, at different, but often close, moments in time. It can be long-term mobility, when people move homes for example, or when a firm relocates to new premises; it can be « short term » or Temporary in the case of people going on holiday, or on work-related trips; or it can be « pendular » for example in the case of individuals who need to travel everyday in order to go to various distant work places.

These types of mobility have developed dramatically. This evolution is possible thanks to the development, and above all, the technological improvement of transport technologies: Increasing frequency of flights, increasing number of high speed trains or of highways for example, or the shortening of the time needed to go from one point to another (particularly in the case of the railway).

Transport infrastructure and technologies help to reduce access times or draw individuals closer to places or objects they are interested in, thanks to the multiplication of connections and to the increase in travelling speeds. They promote and facilitate interactions between people, helping them to develop maintain or re-activate relationships. They are at the heart of temporary meetings, which are characterised by a temporary and simultaneous activation of geographical and Organized Proximity by enabling actors located far from one another to meet face-to-face.

Thanks to the development of ICT, actors or groups of actors now have the ability to be at once here and there and therefore to perform a range of actions that transcend location or mobility. Any actor cannot only be at once mobile and physically present in one place, but it can also act in real time in different places. An individual can interact by telephone or through the Internet with people who live in other countries or regions. A firm can act at once locally and globally, for example by making its suppliers compete with each other at global level, or by passing orders on stock exchanges abroad. ICT multiply the possibilities of interactions. Following social psychologists ~~have shown~~ (Walther et al. 2005) computer-mediated interactions mobilize an important part of the cognitive and emotional capacities of individuals and contribute to the creation of new social relations.

Their evolution has above all had an impact on Organized Proximity, in its potential dimensions as well as in its activations. Indeed, ICT are closely related to the logic of belonging and the logic of similarity in that they contribute to the creation of connections and networks between human beings. Furthermore, they enable individuals who are separated by large geographical distances but short cognitive distances to enter into interaction with one another, which used to be difficult in the past. ICT facilitate the creation of relationships between people located geographically far from one another, or between people who have never met.

Temporary Geographical Proximity

In order to account for these processes, let us introduce the notion of Temporary Geographical Proximity (TGP) (Torre & Rallet 2005). The development of communication technologies and ICT facilitates long-distance exchange; consequently co-location no longer constitutes an absolute necessity. A large part of the information and knowledge that are necessary for production or innovation activities can be transferred from a distance, through telephone or Internet mediated exchanges for example (Walther et al 2005). However, times of face-to-face interaction are necessary and beneficial in this context. The example of the Airbus or Renault platform teams, or that of the travelling done by members of R&D (Research and Development) collaboration projects undertaken by biotech start-ups are good examples of such situations. Face-to-face interaction cannot altogether be eliminated, including in the case of communities of practice, for example (See Torre 2008). As a consequence ICT cannot be considered as substitutes of face to face relations: they are useful tools to support or enhance the interaction between two or several individuals.

Space matters, but in a new way; one that consists of Temporary face-to-face contact between two or several individuals. Temporary Geographical Proximity corresponds to the possibility of satisfying *needs for face-to-face contact between actors, by travelling to different locations. This travelling generates opportunities for moments of Geographical Proximity, which vary in duration, but which are always limited in time*[3]*. TGP is limited to certain times; this form of Geographical Proximity should not be mistaken for a permanent co-location of firms or laboratories.*

The necessity of TGP is embodied in the existence of places that are especially made for TGP based activities. In the case of private individuals they can be conferences, theme or recreational parks. In the case of firms or laboratories they are specialized venues. Trade shows, conferences and exhibitions enable actors to fulfil certain needs related to the processes of production, research or innovation (Entwistle & Rocamora 2006). These hubs are readily viewed as Temporary clusters (Maskell et al. 2006), a term which highlights the relation with the permanent clusters. But above all, these places respond to a need for face-to-face relations related to the wish to reduce the costs of transactions (Norcliffe & Rendace 2003; North 1991). Common "platforms" of project teams are also meant to enable the participants of a project to work together for a period of up to several months, in the framework of a project team. It is also the case of the members of a project undertaken by the geographically dispersed subsidiaries of a firm (Aggeri & Segrestin 2001; Talbot & Kechidi 2010).

Business trips are undertaken in order to reach a common decision or determine the characteristics of a cooperation project; or an activity that can only be performed in a place other than the individual's usual workplace. These meetings are needed at regular intervals during the coordination process. Their frequency and regularity are the cause of most business trips. The

[3] The type of mobility we are discussing here is a "long" mobility, one that is not "pendular", for example. It consists of time consuming trips with high transport costs. "Short" mobility, within a local system shall be considered, in a conventional manner, as permanent proximity or co-location.

face-to-face interactions do not, in this case, occur in places exclusively dedicated to meetings, but in "ordinary" places, i.e. in the participants' usual workplaces, firms or laboratories.

II. Assessing proximity relations and innovation within the optics cluster in the greater Paris region

Let us proceed to apply our analytical framework to the study of inter-firm relations. The objective is to understand the role played by the different types of proximity (internal vs external, geographical vs organised, and permanent vs temporary) within innovative firms strategies and behaviours and to understand the balance between local and long-distance relations in the field of clustered innovation activities.

It has been recently showed that innovative firms can have specific behaviours in terms of proximity relations, with regards to their own peculiarities (Dankbaar 2007; Wetterings & Boschma, 2009). We want to investigate this field, with a more precise assumption. Regarding our previous developments, we would like to confirm the intuition that large firms will be more easily able to act at a global scale, with the help of Temporary Geographical Proximity and Organised Proximity relations, whereas smaller ones are more anchored and constrained to stronger local links. This is due to the ability of large organisations to take advantage of travels and mobility due to their financial and human resources. This hypothesis is not an obvious one: one could make the assumption that smaller firms are easily footloose because of a small number of employees, tiny links with local employment markets and unweight fixed capital, especially in innovative sectors based, whereas large firms are spatially anchored due to huge local investments in human or fixed capital.

For the sake of this analysis, our case study must correspond to several conditions:

- we need a well-defined geographical concentration of innovative firms, with attested internal relations and global pipelines;
- we are looking for a diversified population of local firms, with small and big firms, and SMEs, and various technological levels, in order to assess for possible different innovation behaviours related to peculiar situations and competitive positions;

In order to obtain all the necessary information to complete this task, we have focused on a sample of firms displaying the following two characteristics:

- firms belonging to a cluster with a manifest institutional presence, which guarantees the presence of local relations and synergy, without excluding external relations to the cluster;
- firms engaged in processes of production and distribution of innovative products that are sufficiently complex to require the involvement of a number of actors, in other words the activity cannot be carried out by a single entity.

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II.1. The selection of the optics and photonics industry and the method of analysis

The choice of case study

We chose to study firms that develop optical and photonic technology, based in the greater Paris region. This selection was made for four reasons. 1) This cluster has well-defined geographical and institutional boundaries; 2) It encompasses a huge diversity of types of firms, large, small and medium-sized ones, 3) There are important differences in terms of technological levels, from lower medium to upper high tech; 4) There are confirmed internal relations between these firms, as well as strong external links and remote relations.

The greater Paris region has a large agglomeration of actors from French subsidiaries involved in the optics and photonics industry: about half of the French-based industry and research entities in optics and photonics can be found in this location[4], namely approximately 556 firms with more than 16,700 employees and 103 public research teams (more than 5000 employees), thus forming a very large cluster dedicated to these activities. In addition to this significant presence, a high concentration of research activity in various optics-related fields is carried out in major university centres within the region. The area also brings together more than half of the national research entities in the field of optics as well as large scientific facilities.

Optical and photonic technology is characterized by a strong level of technological innovation, it is multi-applicative and supplies all the major strategic industrial sectors. The industry develops critical technology (*enabling technology* and *constitutive technology*; ISTAG 2006) that, when combined with the electronics and software industries, enables the creation of finished products (calculators, endoscopes, film cameras, RFID, CAD, telecommunication networks). This combination with other technologies - especially electronics, signal processing, or mechanics - allows advances to be made in relation to the integration of advanced functionality within sensors or optical equipment, thus opening out the field to new uses such as pollution control, non-destructive analysis and control, image recognition, holographic control procedures... Optical equipment and instruments - which are sometimes in competition with other technological solutions (for example, water jet or plasma for cutting–- are the focus of research that aims to address certain weaknesses such as environmental protection or high production costs (Opticsvalley, 2004). The main markets for firms within the optics and photonics industry are ICT (optical and photonic components), the aerospace and arms industries, health and life sciences, scientific instruments, industrial production and other markets (LED sources with higher light output than traditional incandescent lamps).

The relevant actors for this study were identified using data and knowledge bases developed by the economic development organization *Opticsvalley* and the global competitiveness cluster *System@tic-Paris-Région*, encompassing over 1100 firms in the greater

[4] This significant base in the greater Paris region is characterized by the establishment in 1999 of a structure to lead and promote the optics and photonics sector, *Opticsvalley* (http://www.opticsvalley.org/). Since 2005, *Opticsvalley* has also included branches of software engineering and electronics.

Paris region that carry out production and/or development activities in the optics, electronics and software industries. Of these entities, there are:

- 42 large entities (greater than 100 employees) with over 8500 employees,
- 77 medium entities (between 20 and 99 employees) with over 4600 employees,
- 437 small entities (fewer than 20 employees) with over 3500 employees,

In order to study the characteristics of the optics sector and the interrelations in terms of proximity, we have used two main sources. The first is a database in which all firms based in the greater Paris region (123 firms[5]) that develop and/or produce optical and photonic technology are identified and classified in terms of number of employees, turnover, location, focus on R&D, technology and products developed. The second is the output of 44 qualitative in-depth interviews conducted with the most representative local actors in the industry[6] (industry, research, institutions).

The method

A part of our method is based on the idea that firms could exhibit various strategies with regard to different types of proximity, related to their own peculiarities or competitive positions. For commodity sake, we use the porterian approach of strategic groups, in order to identify different groups of firms, with peculiar behaviours and industrial or innovative dimensions.

In order to identify and classify the main categories of innovative firms, we have used the industry structural analysis method[7] based on tools developed by industrial economics, which aims to study firms by placing them in their industrial context. Industry is defined as a group of firms producing goods that are highly substitutable. The analysis of the immediate competitive environment of firms (i.e. other firms within the same industry) is completed with the analysis of the set of forces external to the industry that affect its competitiveness. Porter (1980, 1998) defines customers, suppliers, substitutes and potential entrants as competitors of greater or lesser importance. He has defined this form of competition as *extended rivalry*. Consideration of the five competitive forces - [1] the potential entry of new competitors, [2] the possibility of product substitution, [3] customer bargaining power, [4] supplier bargaining power and [5] competitive rivalry - shows that competition within an industry far exceeds the competition between established firms in the market and requires a broader view of the environment in which they operate. The overall impact of these five forces determines the profitability of firms within an industry, however it should be noted that this impact varies by industry and can evolve over time.

[5] See Annex 2

[6] 21 industrial firms, 6 economic development organizations, 5 local authorities, 3 financial institutions and 9 public research laboratories.

[7]. The changes in the global economy and the new strategies developed by firms can be analysed by this method, using the basic factors that determine the evolution of an industry (intensity of competition, substitute products, presence of suppliers, customers and new entrants).

1) The potential entry of new competitors

New entrants to an industry can increase overall production capacity, however they also aspire to take market share and can aim to appropriate part of the existing resources. Acquisitions within an industry, coupled with a desire to increase market share, should be analysed as a new entrant even if no new entity is created. Porter's analysis framework highlights the need to consider barriers to entry for the industry under review, working from seven major sources: economies of scale, the degree of product differentiation, the level of risk associated with the capital investment by the firm, switching costs, access to distribution channels, cost advantages independent of scale and the level of state intervention. The likelihood of new entrants to an industry is therefore dependent on the level of barriers to entry and the opinion of new entrants on how existing firms within the industry will react (*expected retaliation*). Indeed, if the barriers to entry are high and/or if the new entrant expects a strong reaction from firms already established in the market, the likelihood of new competitors entering the market is low.

2) The intensity of competition

Existing firms within an industry are mutually dependent in the sense that action from one firm (i.e. price decrease, product enhancement) may result in a reaction from its competitors. The intensity of competition between firms within an industry depends on several structural factors that interact with one another. These factors are: the existence of many similar-sized competitors; a low-growth industry, which pushes competitors to develop acquisition strategies in order to increase their market share; high fixed prices or storage costs, which often prompt a strategy of price reduction when there is production overcapacity in the industry; low levels of product differentiation; a significant increase in production capacity; competitors with a wide variety of different strategies, originating within the firm, from personalities...; and significant switching costs (asset specificity, strategic interactions, high fixed switching costs, emotional barriers, state or social restrictions).

3) The pressure of substitute products

One product can be substituted for another if they both perform the same function. The choice between two substitutable products is based on the price/performance ratio of each product. Product substitutes are not part of the market, but they represent an alternative to those on offer. They could be different products that meet the same need (e.g. MP3 downloads / Compact Discs), or products that influence demand (electric vehicles / fossil fuels).

4) Customer bargaining power

Customers can exert pressure by asking for price decreases, better quality products, more services, thus promoting competition within the industry. The bargaining power of each buyer group[8] is strong when:

- there are few buyers, or the customer purchases large volumes of production output,
- the products purchased represent a significant portion of the total cost or total purchased,
- the products purchased are standardized, or not differentiated,
- the supplier switching cost is low,
- the buyers have a low profit rate,
- the buyers are potential entrants to the industry,
- the products purchased have a low impact on the quality of the buyer's end product,
- the buyer has complete information on market demand, market prices and production costs.

5) The bargaining power of suppliers

Suppliers can exercise their bargaining power by threatening to increase prices or reduce the quality of the products and services supplied. The bargaining power of a supplier group is strong if it is dominated by a few firms and is more concentrated than the industry it sells to, if there is no competition from product substitutes, if supplier products constitute a large portion of the buyer's end product, if the products are differentiated, if supplier switching costs are significant, and finally, if the suppliers are potential entrants to the industry of the customer.

This model has some limitations: it is based on the logic of power in relationships and leaves little room for collaboration strategies which have recently acquired a new legitimacy as a result of the globalization of economies, coupled with increased complexity and uncertainty in technological developments and the markets, not to mention the financial dimension. For this reason, we have included these collaborative relations in our study. In addition, the model implies that the strategy is essentially to adapt to environmental conditions, thus precluding approaches based on resources and skills that foster an endogenous vision of success. Finally, the model can be extended by the addition of a sixth force - the influence of public authorities (State, European Commission, local authorities, etc.) - which does not explicitly feature in the model but whose influence can affect each of the five other forces. The implementation of policies and legislation can affect the manner in which each of the forces impact the market. For example, market entry may be subject to approval or, conversely, it may be subsidized.

[8] One buyer group represents all firms that buy a given product. The firms are not necessarily part of a formal organization with a legal status.

Torre A., Lourimi S., 2013, Proximity Relations and Firms' Innovative Behaviours: Different Proximities in the Optics Cluster of the Greater Paris Region, in Kourtit K., Nijkamp P., Stimson R. (eds), *Applied Regional Growth and Innovation Models*, Advances in Spatial Science, Springer Verlag, Heidelberg, N. York, 360 p.

II.2. The characteristics of the different "strategic groups" of firms within the optics and photonics industry in the greater Paris region

The application of the structural analysis method has led us to identify four strategic groups of firms within the optics and photonics industry located in the greater Paris region. Each group is categorized by similarities in strategies adopted, mobility barriers from one industry to another, the level of bargaining power with customers and suppliers and in their position in relation to substitute products. The categorization of these strategic groups does not preclude interdependence between the respective markets.

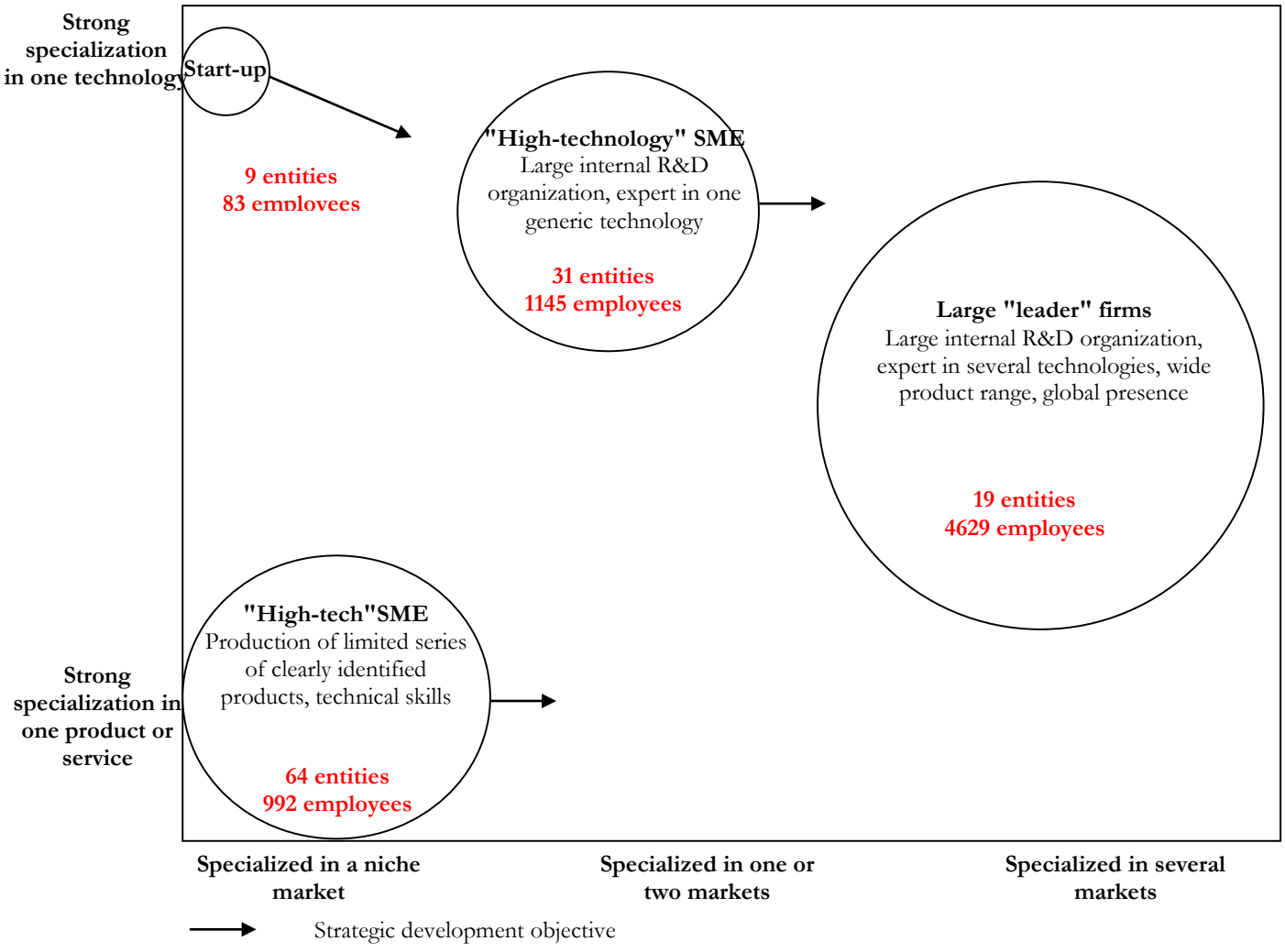

Figure 2: The "strategic groups" of firms of the optics and photonics industry

"Breakthrough technology" start-ups

Firms in the "breakthrough technology" start-up group are characterized by their ambition to introduce new technology products to the market. Solutions developed using recent knowledge do not necessarily have an identified market and the innovation does not stem from a specific or existing need, this phenomenon is known as technology push. This category of firm is identified mainly by the small number of employees (between 1 and 20 in the majority of cases).

Research carried out in large public or private laboratories is the main source of this new knowledge. These laboratories are at the forefront in their respective technology fields and are therefore likely to transform their research and development activities into products, either by knowledge transfer to the industry or through spin-offs. Mastering new technologies introduced by start-ups is the main mobility barrier in this strategic group. They introduce new technology products which are likely to become substitutes for established products in the market. The degree of market penetration depends mainly on the price/performance ratio of the new technology and its ability to establish a new standard in the market.

"High technology" SMEs

"High technology" SMEs are characterized by a large internal R&D organization, enabling them to develop and introduce numerous innovative products to the market at regular intervals. They are identified mainly by their specialization in one generic technology (infrared, lasers...) from which they develop a wide range of products aimed at several markets (health, automotive, aeronautics, environment, defence, telecommunications...).

The significant technological expertise and knowledge acquired by these firms are strong mobility barriers in this strategic group. "High-technology" SMEs have low bargaining power with their customers, with the exception of product co-development initiatives. This is mainly because the customer (often a large firm) is looking for a specific recognized skill that does not exist internally and that can be provided by the SME. On the other hand, the bargaining power of the SMEs generally works in their favour with "standard" suppliers (who sell intermediate products that are in abundance on the market), but is low with "strategic" suppliers (who sell very specific intermediate products that are rare on the market). Finally, the generic nature of the technology used means that the firms are faced with the constant threat of substitute products using other technologies, which can be evaluated using the price/performance ratio (optics, photonics, electronics, electromagnetic...).

"High-technicality" SMEs

"High-technicality" SMEs are characterized by a significant level of technical specialization and by the production of limited series and customized products for clearly identified market niches. In addition to a low focus on R&D, the main difference with "high-technology" SMEs is the fact that while "high-technology" SMEs are experts in one generic technology (which is possibly applicable to several markets), "high-technicality" SMEs are

characterized by their strong specialization in one product or service destined for a specific and clearly identified niche market.

This strong specialization in a product/service, coupled with a specific distribution channel, are the main mobility barriers in this strategic group. These firms have low bargaining power with their customers (large firms, large research laboratories) to whom they supply small quantities of products that are generally not very strategic in nature. However they have a strong bargaining power with their suppliers, because many firms are able to supply the production inputs, including firms based in emerging countries. There are no immediate threats identified in relation to substitute products, this can be explained by the small market size which is not very attractive for potential competitors. However, this strategic group is at risk of the emergence of a new substitute technology with a better price-performance ratio.

Large "leader" firms

The greater Paris region has a significant presence of large multinational industrial groups that develop, produce and integrate optical and photonic technology. Among these are Alcatel, EADS, Safran, Thales and Tyco Electronics, each with greater than 60,000 employees world-wide.

These firms have market relationships that are similar to those of other groups. But their relations with the state, technology and the territory are different to those of SMEs. Indeed, the state may be a shareholder or the only customer of large firms, in certain strategic markets such as nuclear and defence, for example. Unlike SMEs, who often produce technological components (lasers, infrared...), the large "leader" firms play a dual role as producers of certain technological components for their core business, but primarily as integrators and manufacturers of complex systems. They play a major role in the definition of technological standards and products destined for the market and have a balanced bargaining power (sometimes strong when they have the monopoly on a product or service) with their customers (the state or private markets) and a very strong bargaining power with their suppliers. The threat of substitute products is quite weak in the short and medium term, especially as large firms have the financial capacity to acquire competitors who develop products and processes based on a radically innovative technology. Finally, their relationship with territory is characterized by the international organization of their R&D and production activities. They play a leading role in the general economy by buying products from suppliers, co-developing technologies with SMEs or laboratories and identifying actual and future consumer preferences in terms of products and services.

II.3. The proximity relations of firms within the strategic groups

Taking the main elements of our working method and the typologies detailed above, we can draw a graph of the different types of relations between the firms in the Paris region optics sector, belonging to the four strategic groups (~~Figure 3~~). This diagram, based on the existence of "standard" and "strategic" customers and suppliers, as well as partner firms and laboratories, also includes the role played by institutions such as public bodies. Customer/supplier relationships are

part of the value chain and can foster major product development and enhancement activities, while partnerships with other companies or laboratories have more horizontal relationships.

In our case study, the innovative firms maintain three types of proximity relations with their partners. Relations can be:

- Permanent Geographical Proximity relations, activated by Organized Proximity relations and which are based on local interaction through meetings or more informal encounters (face to face). To a greater or lesser extent, these relations may be accompanied by;
- Temporary Geographical Proximity relations, which also rely on Organized Proximity relations and involve the organization of short visits and trips using different means of transport (mobility);
- long-distance Organized Proximity relations that depend on the use of ICT, such as the telephone or internet.

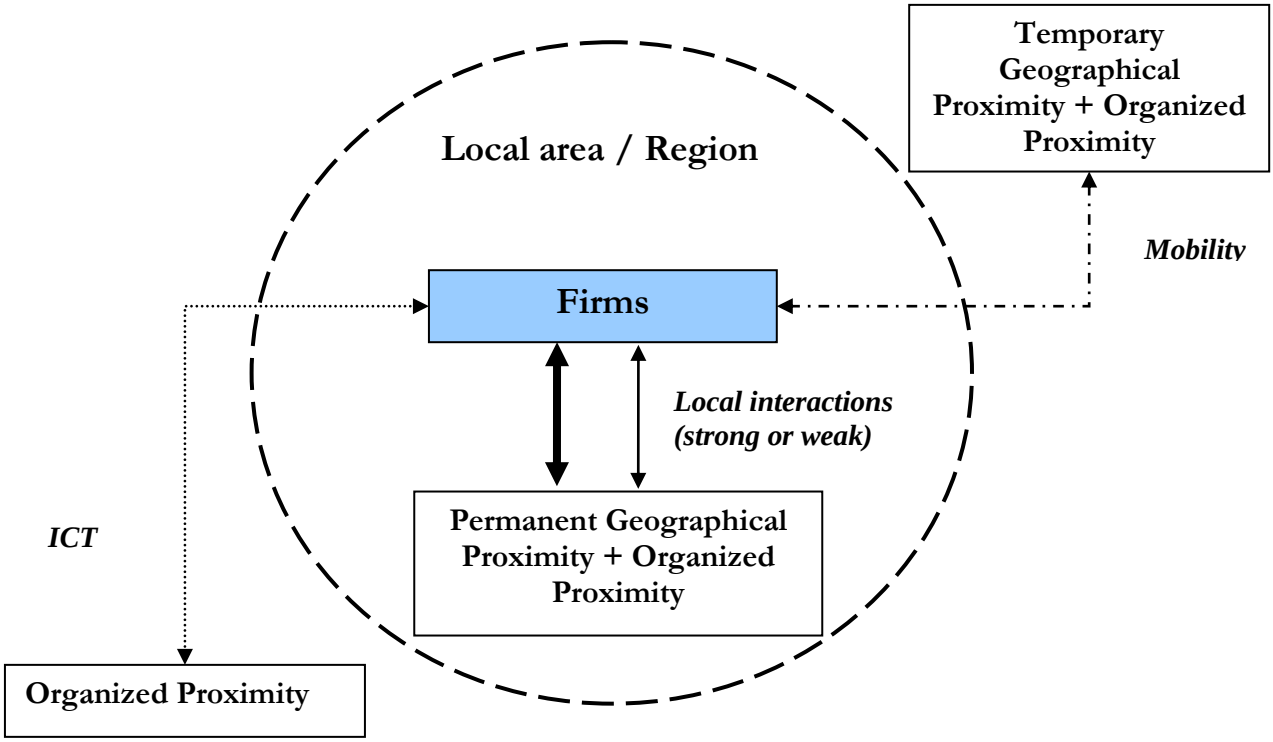

Figure 2: The proximity relations of firms within the strategic groups

This diagram characterizes the relations between firms and their local or wider environment in terms of Geographical and Organized Proximity as well as in terms of internal or external links to the cluster. It is only a general and broad image, which does not take into consideration the peculiarities of various groups of firms. In the following diagrams, we try to clarify the respective combination or exclusion of geographical and organised proximity, and we describe the complete set of proximity interactions of firms, while at the same time focusing on the analysis of research and innovation partnerships. We made the choice, for sake of completeness, to maintain other

relations than innovation ones in the graphs, but they are depicted in grey (relations with suppliers or standard customers, for example).

The importance of Permanent Geographical Proximity between "breakthrough technology" start-ups and public research laboratories

The main characteristic of "breakthrough technology" start-ups is to attempt to introduce products using new technology to the market. They do not yet have catalogue products and their products are in an operationalization phase, characterized mainly by numerous interactions, especially significant exchanges of knowledge and information with research laboratories and large companies that can be defined as *early users*. These *early users* are the first customers, they identify the new product or service and pinpoint a significant potential application for it within their own production processes or products. *Early users* are: public institutions (national and/or regional) that decide to purchase products or services utilizing this new technology, or public laboratories, that can also be a potential market for these start-ups. They provide initial feedback to the start-up on the feasibility of and interest in their product. This valuable source of information strengthens the ability of start-ups to issue competitive products and services to the market.

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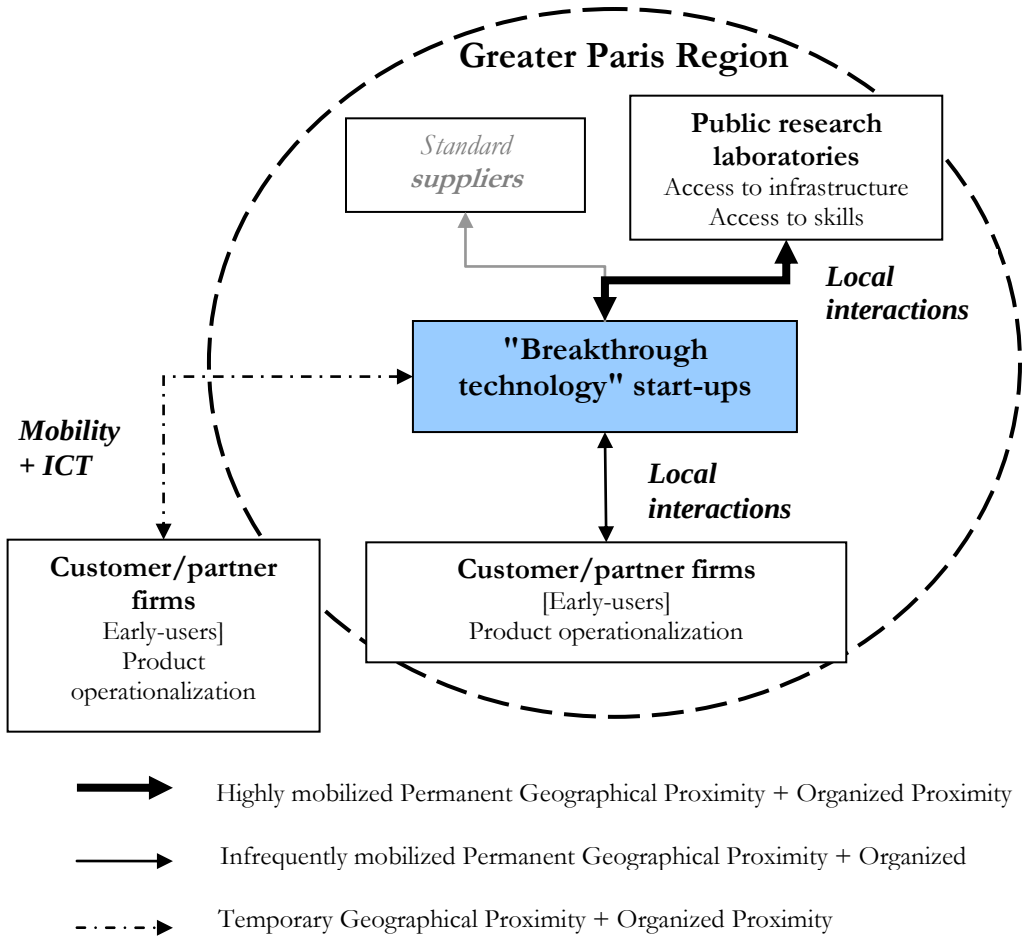

Figure 3: The proximity relations of "breakthrough technology" start-ups

In our cluster, "Breakthrough technology" start-ups have a fundamental requirement for permanent Geographical Proximity with research laboratories (especially with laboratories from where the start-ups originated, which creates a sense of belonging in terms of Organized Proximity). They require access to the skills and tools/infrastructures available in nearby laboratories in order to test and develop their products. The role Geographical Proximity plays is particularly central in allowing start-ups to execute their innovation processes in the product operationalization phase, they are very closely linked to the research laboratories within their local environment, especially with their laboratory of origin. Indeed, the use of skills and tools/infrastructures, which are too costly for a young firm to acquire, are critical and a determining factor in the ability of the start-up to solve technical and scientific problems and propose an end product. These exchanges are difficult to perform at a distance as they require a frequent repetition and mobilize tacit dimensions. Thus, research laboratories are often a source of materials (test and measurement tools, for example) and skills (access to the research skills) for breakthrough technology start-ups, in addition to the existing resources within the firm itself. This relationship is essential for firms with limited financial and human resources (i.e.

insufficient turnover to guarantee the immediate survival of the firm) which restricts their capacity to acquire materials in order to develop new products or services and which anchors them firmly at a local level.

Furthermore, Geographical Proximity plays a greater or lesser role according to the relations between *start-ups* and other firms:

- Permanent Geographical Proximity with *early user* customers is not a prerequisite for effective interaction in the product operationalization phase. Start-ups interact with firms (in general with large groups of firms) that are interested in their technology, regardless of location. The product operationalization phase requires "instant" interaction with a view to adapting the products to specific customer needs and effectively assessing the potential of the new technology in relation to their products or processes. An indispensable factor in this operationalization phase, Temporary Geographical Proximity is mobilized by partners located at a distance from one another, and Permanent Geographical Proximity is infrequently mobilized by relations with partners within the cluster.
- Geographical Proximity is incidental in the interaction between "breakthrough technology" *start-ups* and "standard" suppliers, whether located in the same region or elsewhere, and without the interactions having to be especially strong. Although the purchase of intermediate goods does not require face-to-face contact, it is often carried out locally, especially in the case of economic areas with a large and diversified industrial fabric. The firms purchase their inputs locally if they are satisfactory from a quality/price perspective. This results in occasional relations with other partners in the cluster. The potential of Permanent Geographical Proximity is infrequently mobilized and local relationships are not vectors of knowledge or skills transfer for this category of local interaction, which is easily replaced by supra-local interaction.

The key role of Temporary Geographical Proximity in relation to "high-technology" SMEs

"High-technology" SMEs are characterized mainly by a strong internal R&D organization, required in order to maintain their competitiveness in the global market. These firms need to introduce successive series of products to the market at regular intervals. These characteristics, which push them to establish interaction with other firms and public laboratories, result in very different requirements in relation to Geographical Proximity, depending on their partners.

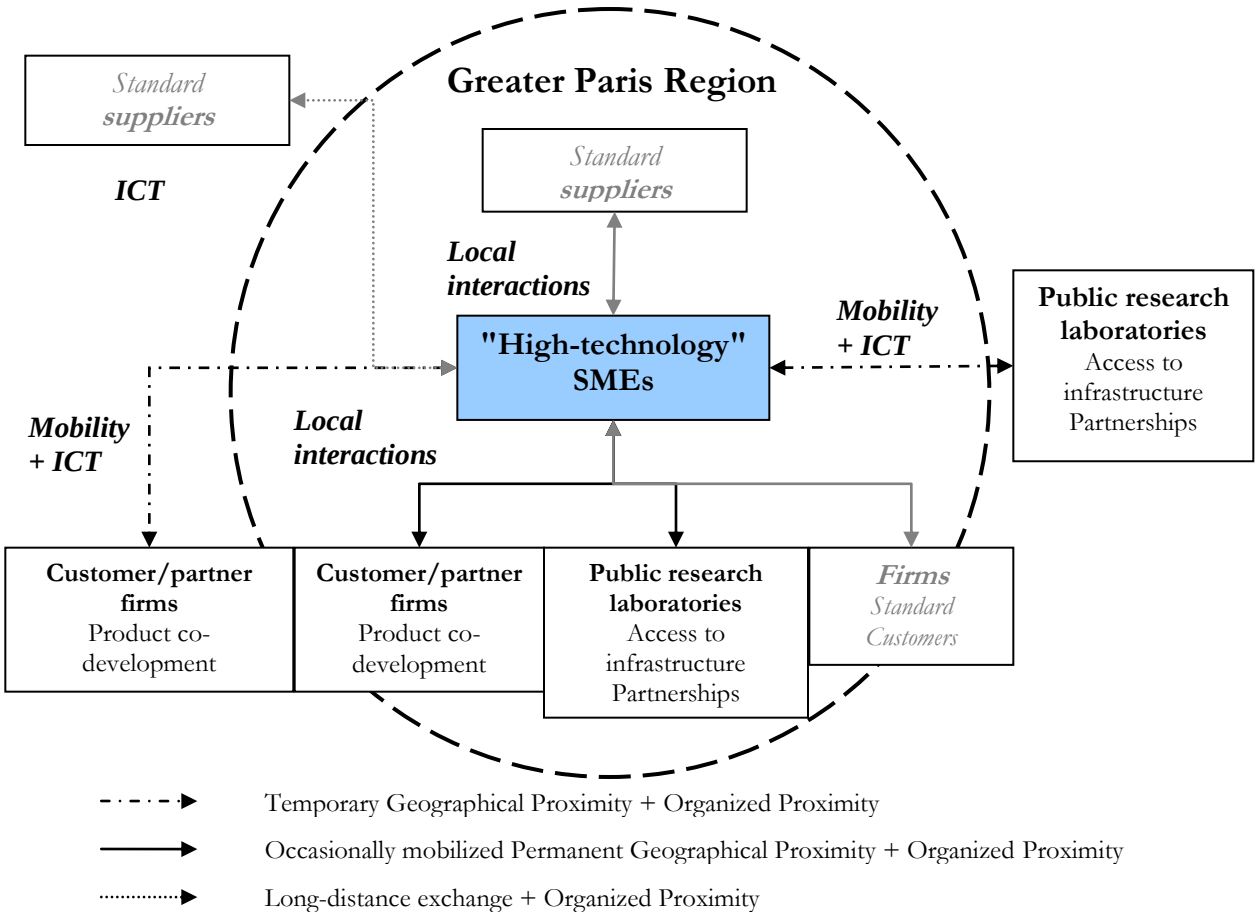

Figure 4: The proximity relations of "high-technology" SMEs

Geographical Proximity plays a central role in the interactions between these firms and their customers/partners. Temporary Geographical Proximity relations with customers/partners situated outside the region are mobilized using ICT during phases of long-distance collaboration. Indeed, "high-technology" SMEs - whose goal is to adapt highly technological products to the new needs of a customer (generally large companies) - have many face-to-face interactions, especially during the requirements gathering phase in which the SME ascertains the customers' needs and the customer evaluates the ability of the SME to supply a complementary technology. Not only does Temporary Geographical Proximity play a fundamental role in these preliminary phases, it is also a key element in the intermediary phases of product co-development and adaptation to the customer's specific needs: Temporary Geographical Proximity manifests itself in the form of meetings to evaluate progress on cooperation projects. Co-location is not necessarily a prerequisite for these temporary meetings to take place: co-location with local customers is more the result of the history of the region and the search for skilled labour.

Interactions between "high-technology" SMEs and research laboratories also require regular meetings, especially in the initial and control phases of collaborative R&D projects when

frequent face-to-face meetings take place. Direct contact is also indispensable if the firm wishes to access the infrastructure and/or skills available in public research laboratories. These relations are all the more important as the actors behave in different ways, according to different logic. Similar to partner firms, there are two different types of mobilized Geographical Proximity for "high-technology" SME/laboratory relations: it is temporary for laboratories located outside the region, and permanent for laboratories co-located within the greater Paris region. In both cases, mobilization is only occasional.

The accessory role of Permanent Geographical Proximity in relation to "high-technicality" SMEs

Our "High-technicality" SMEs are characterized by a high level of technical specialization, by the production of limited series and custom-made products for clearly identified markets. Products produced by firms in this category have technical characteristics that are known and mastered by customers and leave little room for interactive innovation with other firms. The main elements of the incremental innovation process are produced internally using a technology and market watch.

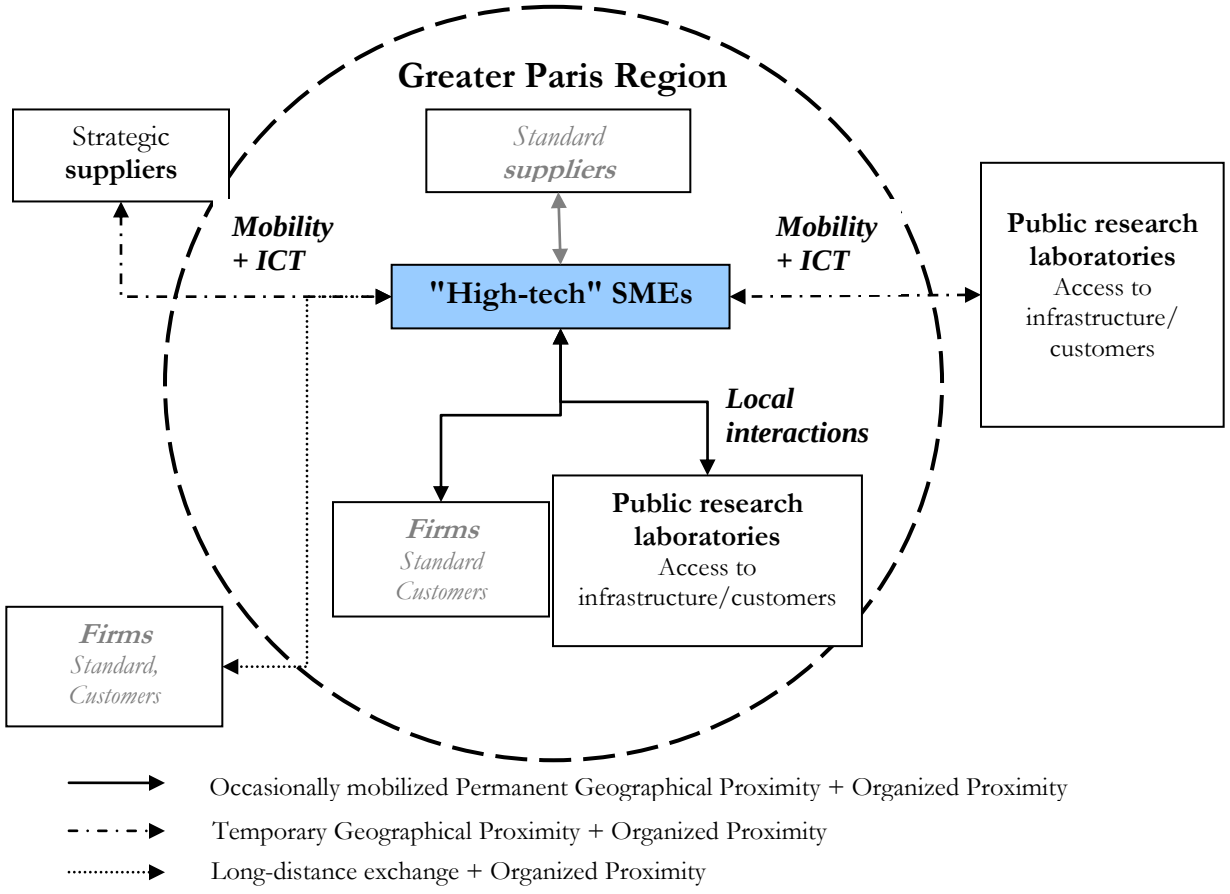

Figure 5: The proximity relations of "high-technicality" SMEs

Nevertheless, Temporary Geographical Proximity plays a role in the innovation process. When interactions with research laboratories take place outside the cluster, they require long-distance contacts, especially if the firm requires access to their infrastructure in order to carry out tests and/or measurements relating to product innovations they would like to introduce. Temporary Geographical Proximity is therefore necessary in the initial and control phases of collaborative R&D projects. Face-to-face contact is also indispensable in the use of tools/infrastructure or skills of public laboratories (shared tools). These laboratories are also customers in the market for products produced by the SMEs. The requirement of firms in this category is to have access to infrastructure (or technological platforms) provided by the research laboratories, requiring travel and mobility in cases where the infrastructure in question is located outside the region.

In contrast, Permanent Geographical Proximity only plays an accessory role in the interactions between the "high-technicality" SMEs and other firms. Products from "standard" suppliers have characteristics that are known and mastered by the customers, therefore they do not require privileged and repeated interactions. In essence, the firms favour local interactions as they allow for greater responsiveness and shorter procurement leadtimes. However, the fact remains that there are greater exchanges of knowledge and information between "high-technicality" SMEs and their "partner" customers or "strategic" suppliers located in others countries than at a local level.

The role of Proximity in relation to large "leader" firms

In the Paris region optics sector, the group of large "leader" firms is radically different to the three other categories due to its relations with technology, the state and the territory. These firms develop numerous different interactions with other firms, ranging from simple customer/supplier relationships at one end of the scale, to the establishment of common research centres or manufacturing units at the other, with product co-development projects and sub-contracting relationships located between the two extremes. They have R&D and manufacturing units located in several countries, but this global organization does not preclude the fact that they need to be located in the major production centres for goods, services or knowledge. One has to notice that these types of rims are not easily fundable in every type of clusters, especially in small industrial districts for example.

Figure 8 below shows the organization of a large leader firm located in the greater Paris region. It maintains relations within the strategic group with an R&D unit (Geographical Zone 3) and a manufacturing unit (Zone 4), and it also maintains external relations with standard suppliers and partners for product co-development (Zone 2). For the purpose of this study, we shall focus on external relations: the role played by proximity is very different depending on the nature of the interactions that large "leader" firms develop with other economic actors, whether located in the region or elsewhere. The complete range of proximity types is represented below.

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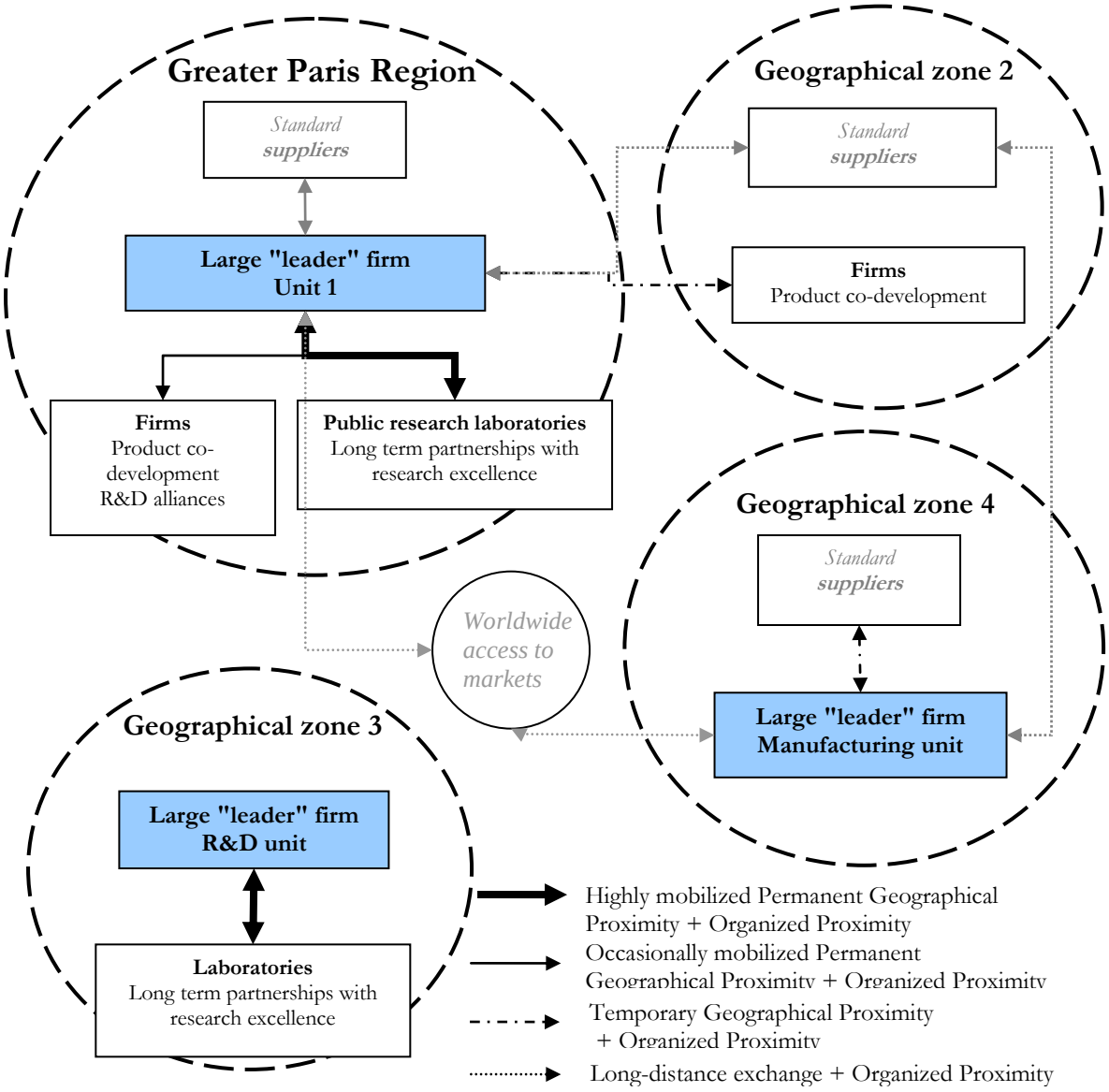

Figure 6: The proximity relations of large "leader" firms

It should be noted that two broad categories of strategic relations, involving significant exchanges of information and knowledge, result in a strong mobilization of proximity relations:

- Permanent Geographical Proximity (co-location) plays an important role in the ability of large firms to establish long-term close relations with research centres of excellence (public laboratories). An example of this is the location of *Thalès Research and Technology* or *Danone*'s global R&D Centre on the campus of the *Ecole Polytechnique*, at the core of several research centres of excellence.
- Temporary Geographical Proximity (face-to-face meetings) plays an important role, especially in relations where the large firm seeks to co-develop a new product (or to adapt

it according to its needs). This is the situation for collaborative relations with "high-tech" SMEs located outside the greater Paris Region.

On the other hand, relations with standard suppliers or partner firms located in the region only involve the occasional mobilization of Permanent Geographical Proximity relations, while relations with standard suppliers located outside the region always require long-distance exchanges.

Conclusion

The aim of this paper was to analyse the different proximity relations (internal vs external, geographical vs organised, permanent vs temporary) maintained by clustered innovative firms, using an applied example, and to explore the management of different types of proximities related to firms peculiarities. In order to achieve this objective, we began by outlining the main characteristics of Organized and Geographical Proximity relations and their permanent and temporary elements. We then applied our analytical framework on innovative firms within the optics cluster in the greater Paris region, by applying the Porterian analysis method of strategic groups. We finally highlighted four groups of innovative firms that maintain specific geographical and organised relations and mobilize local relations and long-distance exchanges using mobility or ICT.

Our results are a first attempt to investigate the field of differentiated innovative firms behaviours related to proximity relations. The figures about the optics cluster in the Paris region show that the proximity approach allows for a better understanding of the strategies and the behaviours of innovative clustered firms with regards to their own peculiarities. More precisely, they reveal that the four groups of innovative firms have different profiles in terms of management of proximity relations, be there strategic interactions or more standard market relations. In particular, proximity mobilization patterns in terms of strategic interaction and partnership strongly vary depending on:

- the size of the firms
- the maturity of their technology or their technological level (from low to high tech)
- their place in the value chain
- their degree of specialization.

Thus, we have showed once again that the propensity to access external knowledge is unevenly distributed among clustered firms (Biggiero & Sammarra, 2010). Despite the fact that all of the innovative firms develop interactions with partners, there are strong specificities in relation to knowledge exchange. A firm that is expert in a technology in an introductory or growth phase needs to develop strong external interactions (collaborative R&D, product co-development, new product operationalization) to create or reinforce its competitive advantage. On the other hand, if the product is based on mature technology, external interactions are less knowledge intensive and do not necessarily lead to the creation of a competitive advantage.

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We have also confirmed the intuition that large diversified firms are likely to mobilize the resources of the various proximity types and remove local constraints. At the other end of the scale, smaller, more specialized firms are more anchored, dependent on their local relations and trapped within the cluster. There have to highly rely on Geographical Proximity in order to build permanent or repeated innovation linkages. Let us add that public policy must take into account the diversity of the various strategic groups of firms with regard to the local situations; they have to avoid excessive focus on the so-called cluster effects and the supposed positive effects of geographical proximity between firms of various sizes which often do not share the same objectives in terms of competitivity or technological choices.

Our study also paves the way for future research in the field of proximity relations related to industry and technology life cycle. "High-technology" SMEs, which are mainly characterized by a strong internal R&D organization and by their specialization in one generic technology from which they develop a wide range of products aimed at several markets, appear to be strongly dependent on both types of Geographical Proximity, be there permanent and local relations or temporary relations and external links to the cluster. On the other hand, "High-technicality" SMEs, which are characterized by a significant level of technical specialization and by the production of limited series and customized products for clearly identified market niches, appear to have accessory links at the local level, and to be rather dependent on external strategic suppliers or public labs.

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ANNEXES

Annex 1: Method of identification of optic-photonic firms

The identification of the optic-photonic firms took three steps.

First step: we used the most representative NAF codes of the optic-photonic activity as a starting point to identify the French located firms which produce, develop and/ or put these technologies on the market (codes 331A, 332B, 333Z, 334A and 334B on the data bases Kompass, Astree and Coface). More than 2500 firms declare their activity under these NAF Codes in the Greater Paris

Region (NAF Code is one of the INSEE (French National Institute of Statistics) Codes. It aims at identifying the main activity of one firm or one association)[9].

Second step: we identified the local firms whose activity is built upon optic-photonic technologies, based not only on the NAF Codes but also on various information (including web sites). The goal was to identify the firms which develop, produce or put on the market products and services based upon optic-photonic technologies.

Third step: this list was validated and completed by the extensive set of information collected through firms visits performed by *Opticsvalley*. This operation allowed us to integrate in the data base several firms which do not declare an activity related to the previous NAF Codes whereas optic-photonic technologies remain crucial in their activity.

Then, the identification by means of the only NAF Codes revealed to be incomplete. We subsequently incorporated some firms registered under the following NAF codes: 221J, 261C, 285D, 300A, 312A, 313Z, 321A, 331B, 334A, 511T, 722A, 722C, 731Z, 741G, 742C and 743B.

Annex 2: List of the optic-photonic firms in the Greater Paris region, on which is based our study

Company Name	NAF Code
AA OPTO-ELECTRONIC	311A
ABSYS	519A
ACMEL INDUSTRIES	311B
ACOME	313Z
ADVEOTEC	742C
AGATEC France	332B
ALCTRA	742C
ALTAIR VISION	722C
AMPLITUDE TECHNOLOGIES	334B
AOIP INSTRUMENTATION	332B
APRIM VIDE	332B
APS	285A
ATI ELECTRONIQUE	312A
AXMO PRECISION	518M
BALOGH SA	333Z
BIORET	731Z
CAMECA	332B
CEDIP INFRARED SYTEMS	742C

[9] List and description of the NAF Codes can be find at the following address : http://www.insee.fr/fr/methodes/default.asp?page=nomenclatures/naf2003/naf2003.htm

CHIMIE METAL	332B
CLARA VISION	511T
CLO ELECTRONIQUE - GROUPE ACJH	312A
COKIN	334B
CONTRINEX	518M
CORNING SAS	261J
CORNING SAS	742C
COSE CONSEIL ET SERVICE	742C
CS DEVELOPPEMENTS	742C
D-LIGHTSYS	334B
EADS SODERN	332A
EGIDE	312A
ERECA	322A
ESSILOR INTERNATIONAL	334A
ESSILOR INTERNATIONAL	334A
ESSILOR INTERNATIONAL	334A
ESSILOR INTERNATIONAL	334A
FASTLITE	518L
FORT	334B
GAUTHIER PRECISIONS	285D
GENEWAVE	731Z
GENOPTICS	332B
GERAILP [CLFA]	NA
GESEC	743B
GROUPE COUGET OPTICAL	524T
HAUSSER ET CIE	285D
HGH SYSTEMES INFRAROUGES	334B
HOLOGRAM INDUSTRIES	221J
HORIBA JOBIN YVON	332B
HORIBA JOBIN YVON	332B
IFRATEC	323Z
IMAGINE EYES	331B
IMSTAR SA	722A
IVEA SAS	741G
IXSEA	332B
JGB	334B
KALUTI SYSTEM	518J
KINOPTIK SYSTEMES	742C
KYLIA	334B
LASELEC IDF	334B
LASERLABS	332B

LASOPTIC	742C
LCI - LE CONTROLE INDUSTRIEL	332B
LEOSPHERE	332B
LHERITIER SAS	331A
L'OPTIQUE COMMERCIALE	334B
LORD INGENIERIE	742C
MAUNA KEA TECHNOLOGIES	731Z
MB OPTIQUE	742C
MC 2	334B
MECAPROBE ENGINEERING	285D
MEIRI	742C
MENSI SA	742C
MICRONIC	321A
MICROVISION INSTRUMENTS	742C
NANOVATION	742C
NEMOPTIC	742C
NETTEST FRANCE	741J
NEW VISION TECHNOLOGIES	743B
NEXANS FRANCE	313Z
OMMIC	321C
OPA OPTICAD / OPTO SYSTEM	742C
OPTECTRON INDUSTRIE	321A
OPTEL-THEVON	742C
OPTIMASK SA	321C
OPTIPHIC	334B
OPTIQUE DE PRECISION J FICHOU	334B
OPTITECK	334B
OXALIS LASER	742C
PHASICS	332B
PHILIPS MEDIA FRANCE	516J
PICOGIGA INTERNATIONAL	321C
PLASSYS	333Z
QUANTEL SA	334B
R&D VISION	731Z
R2B - OPTIQUE DE PRECISION	334B
RADIALL	312A
RENAUD LASERS	518A
SAINT-GOBAIN RECHERCHE	731Z
SAMMODE	315C
SATIMAGE	722C
SCROME	742C

SDTIE INTERNATIONAL	332B
SEDI FIBRES OPTIQUES	518J
SOCIETE D'OPTIQUE MARIS DELFOUR	334B
SOPRA	332B
SOTIMI	261J
SOVIS OPTIQUE	332B
SUEZ ENVIRONNEMENT	410Z
SYSTEME OPTRONIQUE INDUSTRIEL [SOI]	742C
TED TID	527C
THALES LASER SA	334B
THALES OPTRONIQUE SA	332A
THOMAS SINCLAIR LABORATOIRES	731Z
TOFICO	334B
TOPPAN PHOTOMASKS FRANCE	321C
TRANSLUX	261J
TRIBVN MEDICAL	221J
ULICE OPTRONIQUE	332B
UNITED VISION	741G
VERRE ET QUARTZ FLASHLAMPS	315A
VERRE INDUSTRIE	261C
VIPS FRANCE SARL	300A