Connecting Capabilities through Technological Centres

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Paper prepared for the 19th IMP Conference, University of Lugano, Switzerland
4th – 6th September 2003

19th IMP Conference

University of Lugano, 4th – 6th September 2003, Lugano, Switzerland

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Abstract

Recent perspectives on a capabilities view of the firm often recognize the need for firms to develop an external organization. Within the IMP tradition, it is recognized that the external organization may include economic and non-economic exchange relationships. However, greater emphasis is given to the former. The relevance of relationships for firms and for industries can be linked to their role in the generation and diffusion of knowledge. In this paper we will discuss the potential role of technological centres (TC's) as part of firms' external organizations and emphasize TC's role in connecting economic and non-economic exchange relationships. It is further suggested that the motives and the benefits perceived by firms and, in general, the relevance of sharing experiences within these contexts should be seen in the wider context of firms' specific and idiosyncratic trajectories.

1. Introduction

It is commonplace to say that the amount of knowledge generated has been increasing at growing rates[1]. This may translate into a substantial growth of the range of areas of knowledge that firms will have to cover (Pavitt, 1998) both within their proprietary boundaries and through relationships, because those processes should be seen as involving the interplay of different actors (Håkansson, 1987). In particular, buyer/supplier relationships acquire strategic relevance as the increasing division of labour and knowledge may be accompanied by the need to integrate and develop knowledge within and across firms. However, as Easton and Araujo (1992, p. 63) noted "economic exchange relationships have dominated the theoretical and empirical work on industrial networks and direct relationships not of that kind have largely been ignored". This also means that knowledge creation is usually seen through the lenses of economic exchange relationships between buyers and suppliers. There seems to be no reason for this because direct and indirect relationships between firms and research institutions, universities, industry associations, or other institutions may "have a continuing impact on the operation of the network as a whole" (Easton and Araujo, 1992, p. 68). These authors suggest that if "…network behaviour cannot be satisfactorily explained by recourse to economic exchange relationships alone, then other types of relationships must be admitted (*op. cit*., p. 81)[2]. This seems to be particularly true with regard to the issues of technological development.

This paper seeks to discuss how firms' relationships with technological centres (TC's) can have a significant role for firms involved in joint activities with such institutions. To that purpose, and lacking a better label, we resorted to what Foss (1999) has called the neo Marshalian approaches to the dynamics of industrial systems. These perspectives share with the industrial network approach both some common predecessors, *e.g.* Penrose (1959)[3] and Richardson (1972), and the notion that "the industry/the network is more than the sum of the capabilities of firms" (Foss, 1999, p. 7). This perspective is consistent with the basic assumption that relationships between firms can be connected. Besides, it supports the need to consider the relationships with TC's in the context of other relationships, namely those of vertical nature, between suppliers and buyers.

The paper starts, in section 2, by combining those perspectives and defining the dimensions of interest for the evaluation of the potential of firms' relationships with technological centres. In section 3 we present some empirical illustrations, based on the

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[1] As Hudson (1999) says, looking at firms and industries from the knowledge perspective may become nearly obsessive and also give out the wrong idea that the role of knowledge in our society' is an entirely new phenomenon.

[2] Welch *et al*. (1996), for example, discussed the role of Australian industry associations in the promotion of exports.

[3] A host of approaches claim that same inspiration but not all of them draw all its implications, see (Pitelis 2002). For example, the resource based view (RVB) of strategy (*e.g.* Wernerfelt 1984; Peteraf,

cases of two firms and a technological centre. In the final section of the paper we advance some concluding remarks.

2. External organization and connected relationships – The role of Technological Centres

The evolutionist perspectives of industrial systems have stressed the role of the generation of knowledge in industries and the importance of maintaining variety in the institutions involved in such processes. It has been frequently underlined that those institutions can go well beyond firms; see, for example, the studies about innovation systems (e.g. Lundvall, 1992) or industrial agglomerations (Kirat and Lung, 1999; Maskell, 2001). Those perspectives and that adopted in this paper share the notion that knowledge is partially tacit, limited and disperse in nature. Time matters and the dynamic and idiosyncratic nature of firms is intimately associated to their evolution throughout time, not so much in terms of their given or fixed resources but rather of the capabilities that underlie the extraction of services from the resources they control (Penrose 1959).

The notion that firms are not "islands" (Håkansson and Snehota, 1989) is consistent with the pioneering work of Richardson (1972) in its broadening of the Penrosian perspective of the firm in approaching industry organization. He starts from the basic notions that any activity in an economic system only exists in the context of other activities and that the nature of the ensuing interdependencies is intimately associated to the dynamics of capabilities, *i.e.* knowledge, experience and skills that underlie its execution. Thus, Richardson argues, planed coordination does not stop at the boundaries

1993) explicitly acknowledges its inspiration in Penrose but Foss (2002, p. 148) argues that "… the of the firm. In particular, closely complementary activities (i.e. those requiring quantitative and qualitative matching) can be coordinated either within the firm or through relationships with other firms. The latter is favoured when dissimilar capabilities have to be deployed in closely complementary activities. Additionally, as Loasby notes (1998a), "the role of such relationships goes beyond the mere access to existing capabilities, as several other benefits (e.g. the development of new product and process) may result precisely from the connection of very dissimilar and closely complementary capabilities". However, it must be noted, time matters when knowledge matters. This means that the perceived degree of similarity is closely related with the evolutionary path of each firm and the variety of its experience through time (Loasby, 1998a).

This vision of firms and industry suggests not only the emergence of a dense network of relationships among firms the (Richardson, 1972) but also, with relation to the 'external organization' of each firm (Marshall, 1920), that "such capital, of course, does not appear in the balance sheet (it would be very inadequately represented by the valuation of brand names which has recently been advocated); and it certainly is not suitable for aggregation" (Loasby, 1991, p. 41).

The open (i.e. incomplete and dynamic) nature of these systems of connections among capabilities (Loasby, 2001; Potts, 2000) and the rejection of straightforward valuations of those connections and their aggregation are consistent with the notion that industrial systems be seen as networks of partially connected and counterpart specific relationships. They are also essential for understanding stability and change in networks (Axelsson and Easton, 1992; Håkansson and Snehota, 1995). This means that an additional dimension for variety among firms and the generation of competitive

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influence from Penrose to the [RBV] is virtually non–existent".

advantage may reside in their different ways to influence and use the relationships in which they are embedded[4].

The development of new products and processes is always present in this context, as the forces for stability and change may acquire a greater visibility and extend beyond the proprietary boundaries of each firm. For example, the notion of product as a 'network entity' (Dubois, 2002) reflects not only the emphasis given to interactive developments between suppliers and clients (Ford *et al.*, 1998, Ford *et al.*, 2002) but also the occasional need for firms to act on the networks of relationships in which they are embedded (Gadde and Håkansson, 2001).

However, the usage of relationships for mobilizing resources and knowledge can go beyond supplier-customer relationships, in particular for technical developments: "Potentially there is a large number of different actors that can be involved in a technical development project together with the focal company. They can be suppliers of equipment, components, material, etc.; customers or customers' customers, trade research institutes or departments of universities, consultants or producers of complementary products, and competitors" (Håkansson, 1987). This suggests that other relationships, beside 'core' supplier-client relationships can have important roles both for focal firms and for the network. Non economic-exchange relationships can vary from strong to weak and they can involve technical, knowledge or social dimensions (Easton and Araujo, 1992).

The point to be made so far is that as the knowledge system is not a reflection of the production system alone. Other institutions may have a role on the access, generation

[4] As Loasby (1998b, p. 174) puts it, "…[a] firm may achieve distinctive advantages through the ways in which it combines external capabilities with its own". See Mota and de Castro (forthcoming) for a discussion of how connected and partly counterpart specific relationships can help explain changes in firms vertical boundaries and Araujo *et al.* (forthcoming) for suggestions that firms boundaries should be viewed as less than clear-cut.

and diffusion of new knowledge (see for example Bell and Albu, 1999). We will argue that such institutions may include technological centres as counterparts in a strategy for improving technical knowledge. We will suggest next that the potential of technological centres can be associated to their role in connecting and spreading tacit and/or codified knowledge among a variety of firms, including rival firms[5].

Technological centres may provide participant firms with valued potential benefits in terms of learning, by allowing them to directly or indirectly access the experiences of rivals. As Easton and Araujo (1992) had already noted, the generation of benefits in terms of learning may be associated to the presence of indirect relationships as direct interaction or trust are not required between rival firms (Maskell, 2001; Malmberg and Maskell, 2002). Such potential for learning ensues partly from the existence of a common language and some diversity, albeit residual, in the experiences of the parties, "because they do things a little differently – but in ways that are easy to understand" (Loasby, 1998a, p. 155). This same view has been advanced in the literature about innovation systems and industrial agglomerations (Lundvall 1992; Maskell 2001; Lawson, 1999). In fact "…variation emanates naturally when firms with somewhat similar bodies of knowledge must act on incomplete and uncertain information" (Malmberg and Maskell, 2002, p. 439). This suggests that firms may consider the advantages of accessing a variety of experiences beside those that they confront in the context of supplier-client relationships. In other words, the possibility will arise for firms to explore the existence of a common or very similar language.

It may the asked whether this kind of possibilities will become available only when firms are located in industrial agglomerations. Certainly, it is not clear that co-location

[5] Langlois e Roberston (1995) base much of their discussion about the boundaries of firms on the nature of knowledge in terms of its level of codification.

of rivals should be a necessary condition for the benefits from participation in technological centres to materialize. Loasby argues that, whether localised or dispersed, “coordination within an industry... is easier if assumptions are shared and rivals are recognized as contributors to the growth of knowledge” (Loasby, 1999, p. 83).

The same question can be considered from a different perspective. Brown and Duguid (1991, 1998, 2001) discuss the permeability of firms’ boundaries in terms of what they call communities and networks of practice. They argued that firms join together different communities of practice, and also that such communities are inserted in networks of practice, which cross the proprietary boundaries of firms. Firms that recognize this may find it useful to initiate actions aiming at becoming part of networks of practice in order to participate in their shared, albeit partly tacit, knowledge. Thus they will become better able to appreciate small variations in the experiences of those involved in such networks. It can otherwise be admitted that firms’ relationships with technological centres may take the form of weak links (Granovetter, 1973; Håkansson 1987), thus creating loosely coupled networks which may operate as mechanisms to counter the potential for excessive lock-in, be it at the level of firm or at industry level (Grabher, 1993; Best, 1990).

A final issue is the possibility for firms to loose on to their competitors some of the secrets that they would rather retain. This can be an inevitable consequence of building a network of relationships (Foss, 1999). Brown and Duguid (1998) suggest that firms may seek to counter such flows “but cutting off the outflow can also cut off the inflow of knowledge (p. 103). Besides, even if such knowledge becomes codified, the ensuing benefits for each firm will depend on its integration in the firm’s specific system of connections, or ‘administrative framework’. Loasby (1998b, p. 177) expresses this idea quite nicely: “A productive opportunity may well depend on a conjunction between 'knowing how' and 'knowing that'…. Even though the knowledge may be public, the connection may not be; and the ability to make such connections may provide a distinctive capability".

In summary, the involvement of firms in technological centre activities may be a means for them to directly or indirectly access the experiences of other firms and individuals in an industrial system. The potential for generation of benefits may be associated to the perceived or real similarity between the activities that may be accessed through those centres and those carried out within the firms themselves, especially the activities that are perceived as most relevant in the context of their relationships with their clients and or suppliers. The nature of relationships with/through technological centres may vary in terms of commitment and or investment. They may operate as weak links, *i.e.* mostly as information channels or they may have a stronger nature, involving the commitment of other resources, in particular human resources since these are critical when issues of access to and generation of knowledge are paramount.

The industrial networks approach would suggest that the benefits from the involvement of firms in the activities of technological centres might, at least in part, arise from their being embedded on connected relationships. An important dimension for the analysis of such potential would be the possibility to directly or indirectly access the capabilities of other firms and actors in specific areas of activity perceived as relevant. However, as mentioned before, what is relevant for each firm is in part in determined by its previous experiences over time, especially those that took place in the context of its relationships with other actors.

3. CENTIMFE (the local Technological Centre) in context

The data we will present next were obtained in the context of a wider study developed between 1996 and 1999. Other information has been obtained in the following years, through our regular participation in the events of the moulds industry and within other activities involving CENTIMFE[6], the local technological centre, and the research team.

The industry of moulds for the injection of plastics, also referred simply as the moulds industry, is an interesting empirical context for this study. A mould to inject plastics is in general a unique product built especially for a specific client. The director of the largest Portuguese moulds marketing and engineering firm, with an accumulated production of over 6.000 moulds in 1998, considers that despite the fact that only about five percent of moulds present truly innovative solutions:

> *"Each mould is a particular case inasmuch as the plastic material and the equipment change. We cannot say that what we did for a piece is exactly the same as what we had done for another piece because, for example, the material and its behaviour will be different."*

The uniqueness and complexity of moulds has important consequences for their design and production but these are further complicated by other sources of uncertainty and variability, which affect the moulds and/or the plastic pieces or components that they will produce. The conception, design and engineering of a mould require the combination of contributions from several areas of expertise or knowledge about materials (*e.g*. plastics and steel). A mould is a unique combination of both standard and specific components, which are made up or assembled in a sequence of closely complementary activities, from the conception of the plastic piece that will be produced by the mould to the conception and design of the mould itself and its fabrication, assembly and testing. Insufficient knowledge about the behaviours of materials can

[6] CENTIMFE stands for "Technological Centre for the Industry of Moulds, Special Tools and Plastics".

result in changes or corrections on the moulds and/or plastic pieces that they will produce. Such changes or corrections will usually require one or more activities to be repeated and/or performed anew. The need for corrections is generally due to lack of sufficient or timely knowledge by the supplier about the behaviour of the mould, while changes are a consequence of uncertainty on the part of the client about operating or aesthetical aspects of the plastic piece that the mould will produce. In the latter case, in order to test the mould, it will be used to inject small batches of pieces, which will in turn be experimented in real operating conditions. A supplier may incur serious consequences due to excessive or untimely changes and /or corrections. These may hinder its relationships both with its client and its other counterparts, namely in terms of time to delivery, not to mention the substantial direct costs from the activities involved in the conception, production, assembly and testing of moulds.

Our interviewee from IB, one of the largest independent mould producers, was quite emphatic about changes in moulds.

> *"We are confronted with some dramatic situations of moulds that have been lingering in here for two years. They produce one piece every now and then, every now and then they introduce changes, and every now and then they make an awful amount of 'noise' in our organization. We have a normal planning but we have to change our plans because the client asked us to inject 5o odd sample pieces for a change [he requests we do to the mould]. And we have to go in haste change his mould to make him the samples. And then that stops all over again [concerning that mould]."*

Several actions can be used to reduce the need for changes or corrections and producers do resort to some pre emptying strategies in this respect: accessing the knowledge of some firm which is known to have produced a similar mould; excluding from their portfolio those clients who favour the development [of moulds] by successive approximations (and changes); increasing their specialization in moulds of similar sizes, geometrical complexity and tolerances in order to substantially reduce errors and subsequent corrections, etc. Some firms, however, try to manage a mix of situations or even seek to develop their relationships with clients known for their frequent requests for changes. In the latter case, it may be fundamental for the development and sustainability of the relationships that the producer develops capabilities to support the client during the initial phases of the development of the products that the mould will produce. In general, the need for corrections and/or changes requires the development of capabilities in several areas, like materials behaviour, machining and prototyping.

Firms resort to CENTIMFE for several reasons, including a search for technologies, like prototyping, that will help them avoid some problems with the conception, design and production of the plastic pieces and the moulds to inject them, well before their production stages. CENTIMFE, hence called TC for short, was founded in 1991. The number of its associates, including firms and other institutions, grew steadily to nearly 200 now. The firms associated with the TC include engineering and commercialization firms, suppliers of steel, firms specialized in one or several transformation activities (moulds design, tooling, machining, polishing, etc.), component suppliers (injectors, heaters, electronic parts, etc.), suppliers of software like CAD, and suppliers of industry related machines and other equipment. It is worth noting that two of the firms with the largest local turnovers are predominant members in the Board of the TC.

The SOM Case

SOM is a SME, counting about 80 staff. By mid 90's SOM had to face growing turbulence in its portfolio of clients, including increased variability in the number and value of the orders taken and loss of some clients to its competition. The firm started efforts to stabilize or increase both the size and homogeneity of its client portfolio, according to some, deemed desirable, cumulative criteria: the clients' prospective volume of orders, their openness to consider the suppliers' advice (the clients being possibly problematic in specifying their desired final pieces), and the standards of size and complexity of the moulds sought, including shapes and tolerances.

By then, the firm submitted a project to the TC, which involved other producers and institutions. The project was initially defined as aiming at improvements in the processes of mould projecting and machining, e.g. high speed milling command[7]. One of the relevant dimensions was the need to reduce the deliberate over sizing of some components, a practice commonly used to allow a margin for further cutting on them later on if corrections became necessary. As size is closely related to the pressures needed for injecting the molten plastic materials into the mould, the project also involved the Department of Polymers of the University of Minho. The benefits were expressed as follows, following the first few meetings:

> *"... all the situations where you discuss about certain aspects are important teachings, and also it is the relationship that is important because, at any time, we can talk because we are nearer [to each other], and in the things that are discussed we all learn with one another."*

Even if the benefits in this area are not obvious, access to the CT can have positive consequences, for example at the level of portfolio of relationships, because the firm can develop its relationships based on its capabilities to more actively participate in the design of the pieces to be moulded[8]. It is expected that this allows a better anticipation of problems with moulding the final pieces and with producing moulds, namely by suggesting alternatives that the clients find acceptable, both in terms of the pieces and in accrued efficiency benefits for production activities. Besides, advances in the knowledge about the behaviour of plastic materials can help reduce the need for corrections in the moulds themselves.

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[7] High Speed Milling The usage of this technology may allow better finishing of surfaces and greater dimensional precision, thereby reducing the time required for finishing activities.

[8] Those efforts can be seen as aiming to change the interfaces between SOM and some of its customers (see also Araujo *et al.* 1999).

The IB case

IB employs about 600 people, which means that, in this sector of activity, it is considered a large firm worldwide. The IB group is made out of 15 firms and a training centre, the *Instituto de Tecnologia de Moldes*. Within the group, SET is the unit responsible for product development, project and commercialization. Its origin can be traced to the 1980's but it was formally created as a firm only in 1990. In 1983, the firm pioneered in Portugal the acquisition of CAD/CAM stations, involving a substantial financial effort. Its clients induced this:

> *"[Our clients] pressed [us] to its use [of CAD/CAM] before they themselves knew how to work with [those] equipments or had [qualified] people [to do that]. Initially they set deadlines to firms: 'you must have CAD before date X, so that we can work with you' [they said]. All of them underestimated the time that they themselves would take to use that technology and we, that initially believed them, ended up [a few years later] teaching those clients how to use that CAD that they told us we should have... we got hold of CAD and became aware that we knew better than them how to work with it. This was an incentive for us to do the job instead of them. SET took hold of simultaneous engineering and offered it to its clients as a cost of entry to the engineering capabilities that we did not have [beforehand]. We had to learn before we did have a market."*

Then IB became more involved in the design and development of the pieces to be injected. The knowledge that it has acquired since, about plastics and the joint development of products, became especially useful vis-à-vis some clients who ignored the potential and the limits of plastics as a basic material[9]. The creation of SET was due in part to IB's interest in promoting the exploration and development of rapid prototyping and in continuing to explore the potential of concurrent engineering.

In 1995 IB became actively involved in the administration of the TC, together with one of its major competitors. In 1998 it promoted a project directed at monitoring, exploring

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[9] *"... products [were] that could be defensible if viewed in [made out of] metal, but, viewed in [made out of] plastics, some pieces could not even be reasonably [well] moulded. And we were aware of that, that we were having increasing difficulties in talking with our clients. Many times we had to train our clients' technicians [so] that they could understand what we were discussing about".*

and developing technological advances in rapid prototyping[10]. This project involved the creation of a network of firms and other institutions for this purpose. The TC is responsible in the network for the exploration of the SLS (Selective Laser Sintering) technology. IB became aware of this new technology in 1986. Basically, SLS uses laser beams to cut functional tri-dimensional physical models from a CAD drawing. The laser beam cuts or melts, layer by layer, the material used to shape the desired piece. In the present developmental phase there are still several problems that need to be solved, e.g. in finishing, resistance to fatigue, and stability in time, etc. In any case, to the extent that it will become possible to produce functional prototypes by SLS, it will be possible to test in real operating conditions the pieces obtained by SLS. This will avoid the need to design and produce moulds to inject the prototypes of the plastic pieces, and then to have to subject those moulds to a series of changes following the succession of tests and improvements made on the pieces. Also, ongoing projects are researching ways to combine SLS with other prototyping technologies. It is expected that, as technology matures and spreads, some pieces may start being directly out of in their intended component material, thus foregoing milling activities. This can have a dramatic impact in the industry. According to one of the TC's technicians:

> *"We constantly monitor the development of new materials and the evolution of technology and seek to adapt the acquired knowledge to the needs of industry".*

The placement of the SLS project at TC, beside allowing a close monitoring the exploration of that technology without the involvement of large human and financial resources from one firm only, lets the development of the technology be fostered by the

[10] *"[This technology] will revolutionize many areas of activity. In the beginning it had not been discovered that the pieces needed to be "baked". Also there were not strong enough materials. Nowadays pieces are already made in polycarbonate. [The use of this technology] is not yet disseminated because it is very expensive. The equipment bought by the TC did cost over € 0.5 million. It is a bit like CAD. I could have waited that technology to mature, but then I would have missed any advantages".*

variety of requests placed by others firms or institutions[11]. For example, to produce a model for the lid of an engine's 'intercooler', which had to fulfil some demanding requirements of temperature and pressure, various coatings had to be analyzed and tested. Finally, and inasmuch as SLS may become a real alternative to other prototyping technologies or even to the mould based production of plastic pieces, it is believed that the current commitment with the existing, more traditional technologies, will have to be re-equated. The industry already shows some interest in directly applying the SLS technology to produce small series of piece, especially small pieces without critical surfaces finishing and with relatively small production cycles (Soares and Novo, 2000).

Comments about the cases

It should first be noted that the firms themselves submitted the projects in question. Their relevance stems from the specific problems that firms face (or expect to face) and from their being placed to an entity close enough to the industry to share a common language and similar concerns. Further down we will suggest other activity dimensions that may favour or reinforce proximity. Also, the SOM and IB cases illustrate how projects like high speed milling, rapid prototyping, and the analysis of the behaviour of plastics acquire relevance in face of the firms' relationships with their clients and their intentions in that respect. The cases also show that, due to the institutional nature of the TC and especially the involvement of several firms in its activities, the results of 'internal' activities can, to some extent, propagate throughout the industry. This possibility becomes particularly notorious if we look beyond activities that seek to advance the exploration of existing or new technologies and improvements in their usage.

[11] "A person who is in an University, or elsewhere, sends us the necessary information and we send him [back] the piece [he needs]."

Another dimension in the activities of the TC, which goes beyond the projects referred above, is the carrying out of training programs. Both SOM and IB participate in these training activities and IB also provides training staff. These training courses are mostly organized by request and/or according to the needs of groups of firms[12]. They involve, as training staff, both external technicians and personnel from a variety of firms in the industry (e.g. moulds or materials producers).

The TC also provides services in designing and testing moulds. Some associated firms regularly place orders, sometimes for a whole line of products. This way, the TC works not only as a provider of spare capacity but also as a supplier of complementary services to those firms which do not hold some specific capabilities or resources (e.g. rapid prototyping). By delivering services, the TC's technicians acquire a high proximity to the problems and capabilities of the firms and end up developing capabilities in very similar areas. In fact, the management of the TC has been facing serious problems due to personnel turnover, as local firms hired many of its technicians, because training takes times and not everything can be codified. It is also likely that those technicians become attractive to their prospective employers, at least in part, due to their having been exposed to the variety of problems that the industry faces and to their consequently increased possibilities to appreciate similarities between problems and solutions that have proven adequate.

The set of activities thus carried out by the TC suggests that it can be a relevant actor in the ongoing process of codification and partial diffusion of previously tacit knowledge and generation of new tacit knowledge, the spiral of knowledge referred by Lundvall

[12] A local entrepreneur phrased as follows this aspect of a common language in the local context: "If a certain Mr. X comes to speak about the chemical composition of stainless steel he will certainly not drive much attention. However, if the technician Y comes to speak about his problems with the thermal treatment of surfaces, or about the lack of radiation in some critical zones, or the difficulties faced in

(1996) and Nonaka (1994). Inasmuch as the TC participates in a variety of activities intimately associated to the industry's needs, the knowledge generated in those contexts can be transferred to other actors, directly or indirectly connected with the focal firms. However, the fact that it operates as a link on the 'network of practice' (Brown e Duguid, 1998) does not imply identical impacts on each firm and on the industry. Firms can differ in their interests and in their capability to interpret and capture such knowledge (Cohen and Levinthal, 1990, Loasby, 1998b), which, in part, is a consequence of the connectivity of the partly counterpart specific relationships at the level of each firm. Both the involvement of IB and SOM in the TC and the eventual results from those involvements seem to gain meaning in the context of their histories and their economic exchanges with other firms.

The study also suggests that the connectivity of relationships is equally relevant in terms of the benefits that the TC can generate. On the one hand, the transfer of some benefits to competitors cannot easily be avoided, given the very nature of the institution even if they can be perceived and used differently by each firm. On the other hand, the generation of potential benefits seems to be intimately associated to the participation of rival firms presenting a rich diversity of experiences and interests. The question here is to be able to access similar yet sufficiently varied capabilities so that learning does occur. Our informers seem to agree that the benefits from the exchange of experiences handsomely compensate the potential costs due to copying and loss of exclusivity. This may be particularly relevant in an industry in which the complexity of the products and/or the frontiers of knowledge seem to require maintain the possibility to access and mobilize other people's capabilities in future occasions that, recognizably, cannot be anticipated.

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milling, then you can be sure that not a sound will be heard in the seminar room all through the

4. Concluding Remarks

It was said that supplier buyer relationships have been central to the industrial networks approach. They have also been central to the issues of technological development, although it is recognized that other relationships may play some role. Recent approaches to the dynamics of industrial systems have emphasized not only vertical relationships, i.e. access to dissimilar capabilities, but also the possibility of accessing, albeit indirectly, the experience or capabilities, somehow similar, of rival firms. We suggest that connections with the TC's have a potential role at this level but that potential only gains relevance in the context of economic exchange relationships involving clients and/or suppliers.

Our research suggests that the TC's can have an important role in providing indirect access to knowledge generated in other contexts, in particular those of firms with similar capabilities. Our study also suggests that the potential of TC's for learning can be associated to their role as providers of services partly duplicating those provided by or in some firms. Some similarity of capabilities in specific areas can help to maintain a great proximity to and relevance for the context in which firms operate, and thus facilitate the processes of dissemination of knowledge in the industry. Finally, our study suggests that that the motivations and benefits perceived by firms and, in general, the relevance of sharing experiences in this context should be seen in the context of firm's specific and idiosyncratic trajectories. This means that some firms, contrary to others, may consider that their participation in a TC would incur more costs than it would provide benefits, despite both being difficult to estimate in advance. For example, some firms in the industry acquired their own SSL technology equipments and use them for

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presentation and there will be plenty of questions".

their operations with their own clients. Others maintain weak links to the activities of the TC and mostly emphasise their development in the context of their own relationships with their clients and suppliers. Finally others look with mistrust at the activities of the TC and abstain from influencing them. In fact all these varied postures should be recognised as valuable because they bring further variety into the system and, in this respect we do agree with Loasby (1998, p. 157-158) when he says:

> The organization of capabilities is the organisation of systems for generating and testing new and improved skills. The systems are the institutions of economic evolution, which requires specialisation, but not uniformity, within each specialism. There may at any time be 'one best way' of achieving a particular kind of result, but to train everyone within a specialism in that 'best way' would be a recipe for disaster. (Fortunately, there are always a few who escape or resist such training). Diversity is necessarily a system property, and it requires the absence of control; for control frustrates the development of capabilities to which one might later whish to have access.

References

Araujo, L., Dubois, A. and Gadde, L.-E (1999), "Managing Interfaces with Suppliers", *Industrial Marketing Management*, 28 (5), pp. 497-506.

Araujo, L., Dubois, A., Gadde, L-E. (forthcoming), "The Multiple Boundaries of the Firm", *Journal of Management Studies*.

Axelsson, B., Easton, G (eds.) (1992), *Industrial Networks Approach: A New View of Reality*, Routledge: London.

Bell, M., Albu, M. (1999), "Knowledge systems and technological dynamism in industrial clusters in developing countries", *World Development*, 27 (9), pp. 1715-1734.

Best, M. (1990), *The New Competition: Institutions of Industrial Restructuring*, Policy Press: Cambridge.

Brown, J., Duguid, P. (1991), "Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning and Innovating", *Organization Science*, 2 (1), pp. 40-45.

Brown, J., Duguid, P. (1998), "Organizing Knowledge", *California Management Review*, 40 (3), pp. 90-111.

Brown, J., Duguid, P. (2001), Knowledge and Organization: A Social-Practice Perspective", *Organization Science*, 12(2), pp. 198-213.

Cohen, W., Levinthal, D. (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly*, 35, pp. 128-152.

Dubois, A., Pedersen, A-C., (2002), Why relationships do not fit into purchasing portfolio models – a comparison between portfolio and industrial network approaches, *European Journal of Purchasing & Supply Management*, 8, 35-42.

Easton, G., Araujo, L. (1992), "Non-Economic Exchange in Industrial Networks", in Axelsson, B and Easton, G. (eds.), pp. 62-88.

Ford, D. et al (1998), *Managing Business Relationships*, John Wiley & Sons: Chichester.

Ford, D. et al (2002), *The Business Marketing Course: Managing in Complex Networks*, John Wiley & Sons: Chichester.

Foss, N. (1999), "Networks, Capabilities, and Competitive Advantage", *Scandinavian Journal of Management*, 15, pp. 1-15.

Foss, N. (2002), "Edith Penrose, Economics and Strategic Management" in Pitelis C. (ed), pp. 147-184.

Gadde, L.-E., Håkansson, H. (2001), *Supply Network Strategies*, John Wiley & Sons: Chichester.

Grabher, G. (1993), "The weakness of strong ties: the lock-in of regional development in the Ruhr area", in *The Embedded Firm: On the Socioeconomics of Industrial Networks*, Grabher, G. (ed), pp. 255-277. Routledge, London.

Granovetter, M. (1973), "The Strength of Weak Ties", *American Journal of Sociology*, 78 (6), pp. 161-178.

Håkansson, H. (ed.) (1987), *Industrial Technological Development: A Network Approach*, Croom Helm: London.

Håkansson, H., Snehota, I. (1989), "No Business is an Island: The Network Concept of Business Strategy", *Scandinavian Journal of Management*, 5 (3), pp. 187-200.

Håkansson, H., Snehota, I. (1995), *Developing Relationships in Business Networks*, Routledge: London.

Hudson, R. (1999), "The learning economy, the learning firm and the learning region: a sympathetic critique of the limits of learning", *European Urban and Regional Studies*, 6 (1), 59-72.

Kirat, T., Lung, Y. (1999), "Innovation and proximity – territories as loci of collective learning processes", *European Urban and Regional Studies*, 6 (1), pp. 27-38.

Langlois, R., Robertson, P. (1995), *Firms, Markets and Economic Change*, Routledge: London.

Lawson, C. (1999), "Towards a competence theory of the region", *Cambridge Journal of Economics*, 23, pp. 151-166.

Loasby, B. (1991), *Equilibrium and Evolution: An Exploration of Connecting Principles in Economics*, Manchester University Press.

Loasby, B. (1998a), "The Organization of Capabilities", *Journal of Economic Behaviour and Organization*, 35, pp. 139-160.

Loasby, B. (1998b), "The Concept of Capabilities", in *Economic Organization, Capabilities and Co-ordination – Essays in Honour of G. B. Richardson*, Foss, N. and Loasby, B. (eds.), pp. 163-182, Routledge:London.

Loasby, B. (1999), "Industrial Districts as Knowledges Communities", in *Industry, Space and Competition – The Contributions of Economists of the Past*, Bellet, M and L' Harmet, C. (eds.), pp. 70-85, Edward Elgar: Cheltenham.

Loasby, B. (2001), "Industrial Dynamics: Why Connections Matter" DRUID Academy, Winter Conference.

Lundvall, B.-A. (ed.) (1992), *National Systems of Innovation: Towards a theory of Innovation and Interactive Learning*, Pinter Publishers: London

Lundvall, B.-A. (1996), "The Social Dimension of the Learning Economy", DRUID, WP nº 96-1.

Malmberg, A., Maskell, P. (2002), "The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering", *Environment and Planning A*, 34 (3), pp. 429-449.

Marshall, A. (1920), *Principles of Economics*, Macmillan: London.

Maskell, P. (2001), "Towards a knowledge-based theory of the geographical cluster", *Industrial and Corporate Change*, 10 (4), 921-943.

Mota, J., de Castro, L. (forthcoming), "A Capabilities Perspective on the Evolution of Firm Boundaries: A Comparative Case Example from the Portuguese Moulds Industry", *Journal of Management Studies*.

Nonaka, I. (1994), "A Dynamic Theory of Organizational Knowledge Creation", *Organization Science*, 5 (1), pp. 14-37.

Pavitt, K (1998), "Technologies, products and organisation in the innovating firm: what Adam Smith tell us and Joseph Schumpeter doesn't", DRUID Summer Conference, Bornhom.

Penrose, E. (1959/1995), *The Theory of the Growth of the Firm*, Oxford University Press: Oxford.

Peteraf, M. (1993), "The Cornerstones of Competitive Advantage: A Resource-Based View", *Strategic Management Journal*, 14, pp. 179-191.

Pitelis, C. (ed.) (2002), *The Growth of the Firm – The Legacy of Edith Penrose*, Oxford University Press: Oxford.

Potts, J. (2000), *The New Evolutionary Microeconomics: Complexity, Competence and Adaptive Behaviour*, Edward Elgar: Cheltenham.

Richardson, G. (1972), "The organization of Industry", *The Economic Journal*, Sept., pp. 883-896.

Welch, D., Welch, L. Wilkinson, I. And Young, L. (1996), "Network Analysis of a new group exporting scheme: the role of economic and non-economic relations", *International Journal of Research in Marketing*, 13, pp. 463-477.

Soares, R e Novo, C. (2000), "Selective Laser Sintering", *O Molde*, Sept, pp. 18-22.

Wernerfelt, B. (1984), "A Resource-Based View of the Firm", *Strategic Management Journal*, 5, pp. 171-180.