Synergy Between Science/Technology and Local Development: Some Experience in France

Hiroatsu Nohara

SYNERGY BETWEEN SCIENCE/TECHNOLOGY AND LOCAL DEVELOPMENT; SOME EXPERIENCES IN FRANCE

Nagaoka workshop on "the regional development by the collaboration between academia and industry"

September 2003

Hiroatsu NOHARA

Researcher at The French National Centre of Scientific Research

Aix-Marseille University,
Laboratoire d'Economie et de Sociologie du Travail
(LEST-CNRS)
35 avenue Jules Ferry 13626 Aix- en- Provence cedex France
tel: 33 (0)4 42 37 85 00
fax: 33 (0)4 42 26 79 37
e-mail: Hiroatsu.nohara@univ-amu.fr

Introduction

This paper aims to stress the fact that regional development models are heavily influenced by the "national" trajectory of the industrial model, although each local case reflects its specificity due to the actors and the resources which are both heavily embedded in the local contexts (Maurice, Sellier and Silvestre 1986, Nelson 1993). It is not by chance that in response to the economic turmoil of 1980s, French industry ends up being organised in hierarchical and poly-centered regional economies; rather, this fits perfectly with the broader post-war evolution of French industry, which was organised around and pushed forward by the coalition between the French state (government agencies), the public establishments (university, national labs etc.) and the large firms (Cohen 1992). The imperatives of international competition, or perhaps the particular translation that French economic and political "elites" gave to that crisis was in large measure shaped by the post-war experience, and thus revolved around the public institutions as the major agent of change. It was not necessity, perhaps, which pushed French industry into this particular model, but it was not entirely open either. The past is reflected in the present.

If one compares this with the stylised pictures of regional economic development in Italy, Germany or the UK, one sees, beyond some shared characteristics, very different development patterns emerging. In Italy, the industrial districts resurfaced after 1969, in large part conditioned by the pre-existing social and political structures of these regional economies (Brusco 1986, Becattini 1990) and, perhaps, their "incomplete integration" into the dominant Italian development model. The German regional model appears to be perfectly consistent with broader characteristics of the German political economy, such as the role of strong employer associations in forcing individual firms to contribute to public goods such as training and technology transfer (Hancké 1996, Soskice 1996). And the absence of such employer associations in the UK might help explain why mutually supportive regional networks of firms (Marshallian industrial districts) never re-emerged after their demise at the end of the previous century. It is beyond the scope of this paper to develop this argument in full, but the comparative analysis of the stylised pictures of the development of regional economies in different capitalist countries, may suggest strong continuities between the development path followed in different countries throughout the post-war period, and the trajectory of industrial adjustment after 1980. Different nations, we can say, yield different forms of regional economic development.

French experience of regional economies, "Technopôle or Technological districts"

Given the central role of the French state in the promotion of regional economies, the public policies tend to stress the importance of combining the "sustainable" local development with the various features of national life, that is, Industry, Transportation, Education, Science and technology, and Quality of (working) life etc. In particular, the co-operation between industry and academia/research, which have been characterised by the pursuit of "technological excellence", often in the name of national sovereignty, is heavily put forward. As the case of the Plan-Calcul - National Project of Computer Industry's Promotion – (Nohara and Verdier 2001) illustrates, major scientific and industrial programmes (nuclear, telecommunication, aero-space etc.) have been initiated by state bureaucracy and implemented by public establishments with a large degree of financial autonomy. Centralisation of technological innovation capacities[1] has gone hand in hand with a preoccupation with national and regional development, which has led the state to intervene by making financial contributions to regional economic development and installing scientific and technical infrastructures.

Of course, however powerful, the state technocracy can't make all the thing; at the beginning of 1980s, France launched an ambitious decentralization programme called "regionalization". After the Left electoral victory of 1981, decentralisation and regional industrial policy received a new impetus. These reforms should be new regional development

[1] In Consequence, there is a strong concentration of research in the Paris region (one quarter of all lecturer-researchers and half of all researchers) and a few regions in the provinces, to the detriment of the rest of the country.[1] Industrial research is also concentrated in the Ile de France (Paris region) because of the high share of major firms located there, which account for 58% of the researchers[1] employed by firms. After the Paris region, the Rhône-Alpes and Provence-Côte d'Azur (PACA) are the regions most richly endowed with public-sector researchers. The Midi-Pyrénées and Rhône-Alpes are in second place behind the capital in the league table of industrial research.

Evaluation of French academic output in terms of publications reveals that the Paris region dominates all the other regions across the whole range of disciplines (particularly mathematics, physics and medical research). Other regions have particular strengths in several disciplines: Rhône Alpes in physics, chemistry and sciences for engineering, PACA in astronomy and applied and basic biology. Analysis of patent applications reveals the specialisation of the Paris region (which accounts for 41.3% of all French patents) in technological research in the field of electronics (49.2% of French patents), in fine chemicals and pharmaceuticals (49.4% of patents) and instrumentation (44.6%). Rhône Alpes (with 15.6% of all patents) has a relatively strong position in basic chemical processes and metallurgy (18.9%) and in electronics-electrical engineering (17.1%)

instruments aimed at reducing the territorial inequalities that had built up over the post-war period; their rationale became economic as well, since the policy makers realised that France's overall economic performance was strongly dependent upon a dense tissue of high-tech SMEs, and creating a local support structure for such small firms was impossible to organise from Paris. Thus the reforms installed a network of regional and local institutions, all aimed at assisting SMEs in their modernisation drive, and creating new opportunities for economic growth in the local communities. The reform entailed, beside a regional extension of the traditional financial aid to firms, a regional planning system, envisioned as the regional *pendant* of national industrial policies, which implemented broad centrally defined goals, and would operate in four areas. First, they should encourage innovation, through the dissemination of information, and the organisation of technology transfer and licenses. Thus regional technology centres were founded or revamped, and the Ministry of Industry regionalised part of its operations through the regional industry directions DRIRE. Secondly, regional authorities would help small firms with searching for markets, especially export markets; again the DRIRE, in co-operation with the Ministry of Foreign Trade, would be the institutional actor on the terrain. Third, gradually the professional training system would be regionalised, thus allowing the regions to adapt their schooling system to local needs. Fourth, in the wake of the financial reform of 1984, attempts were made to redesign the financial system in order to bring creditors closer to much under-financed and financially somewhat isolated SMEs. Finally, the relations between the regions and the state were organised in the "contrats de plan" -five-year contract between state and region for the realisation of regional programmes- (the law of 17 July 1982), which linked regional and central planning[2].

In such a political context, the state tried to create some high-tech industrial district-type regions in the vicinity of many large and medium-sized cities, which corresponded to reinterpreting Silicon Valley in light of the French experience. There is presumably no French city with some claim to fame, which does not proudly display a "technopôle or technological district". The basic idea behind the "technopôles" is to bring together, in the same geographical area and financially and logistically supported by both the local government and the public

[2] The effects of these policies have been the topic of much debate in and writing on France. By and large there are two positions in the evaluation debate. The first, which emphasises the long way that French political-economic organisation came since the heyday of the centralised state, is, in all, rather optimistic. The other points out how the institutional heritage associated with the central state shines through in every success. Even when regional policies

agencies through a publicly-run "research centre", "incubation infrastructure", tax advantages and small spin-off firms that are potential leaders in new technologies. Thus the local governments obtain, in principle, the means to "create" high-tech industrial districts by attracting innovative or foreign (multinational) firms, and then put some of their financial and institutional weight behind them through the local economic development agencies.[3]

As far as the IT industry in particular is concerned, the various national programmes designed to boost the electronics industry have contributed to the development of certain regional technological centres, first of all through the choices made in the location of public-sector research establishments [4] (CNRS-National Centre for Scientific Research, INRIA-National Institute of Computer Science, etc.), second, through the expansion of engineering schools "Grandes Ecoles" and finally through the establishment of research facilities by public and private companies with high scientific potential (CEA -atomic agency-, CNET -telecom- etc). Such means have permitted the development of an infrastructure on which local co-operative networks can be based, although the precise form of development has differed from one centre to another. The system of co-operation between industry and research in the French IT industry thus remains largely modelled on a past policy of large-scale scientific programmes. It may be noted that the Esprit series of European programmes had no effect on existing co-operative networks and did not replace them with new arrangements. Naturally, the Esprit projects in which Bull and Thomson, as well as many software and IT service companies and research institutions such as INRIA (National Institute of Computer Science) and university teams, were active participants, allowed research networks to be extended on a European scale and brought the various players in the European IT industry closer together. From the French perspective, however, the constitution of European networks has taken place within existing local and co-operative arrangements, notably those focused around regional centres. Being

---

seem to yield results, in reality, the central state reappears in another disguise. On balance, most authors seem to agree that the regionalisation policies have come up short of what they promised.

[3] The links with the rest of the French state apparatus, and especially its economic development agencies (Datar and Anvar) and international trade office, can then be used, in addition to the local tax breaks, to give firms some competitive advantage in foreign markets. Datar is a inter-ministerial (powerful) agency aiming at the co-ordination of territorial policies; Anvar, an agency for innovation attached both to Ministry of Science and Technology and Ministry of Industry, provides technical and financial support to small and medium-sized businesses (2000 employees or less).

[4] France is equipped with numerous national scientific institutions (national academic labs) such as CNRS (26200 permanent posts), CEA (atomic agency; 11500 permanent posts), CNET (4500 permanent posts), INRIA (715 permanent posts) etc. This is one of the most important characteristics in French system of innovation, compared especially with the Anglo-Saxon countries.

established in a locality does not, therefore, seem to conflict with the extension of co-operation between the industry, universities and public research to the European scale.

Regional development around IT technologies[5]

Apart from the greater Paris region (Ile-de-France), which accounts for half the national R&D capacity, there are four other dynamic regional centres for electronic technologies with a high IT component.[6]

By far the most important centre outside Paris is the Grenoble region. Often dubbed the French "Silicon Valley", this area occupies first place in the European-league table for micro-electronic research. In particular, the semi-conductor industry benefits from synergies based on a close link between research and production. This region accounts for 10 percent of national expenditure on R&D in electronics and it employs 600 researchers, 1,900 engineers and 500 designers of integrated circuits in semiconductor industry. The region has a strong university tradition, which acts as a catalyst for co-operation between public-sector research establishments and engineering schools and companies, including both large groups (Bull, Hewlett-Packard, Thomson, Cap-Gemini etc.) and small and medium-sized firms such as Slimag in the production of reading heads of hard disk, Jay Electronique in optoelectronics, Robobat in software packages of structure calculation or Polyspace (spin-off of INRIA) in software validation tools.

The second centre is constituted around Motorola and IT firms linked to the aerospace/space industry in the Toulouse region. This concentration was explicitly created through national policies in aerospace, space sciences and electronics, namely the decentralisation of the CNES (National Centre for Space Science), the location of Airbus-Industrie and the arrival of Motorola within the framework of the Plan-Calcul. This is the location of one of Motorola's semi-conductor production plants, as well as a research centre in power integrated circuits which it runs in conjunction with the CNRS. In addition, the aeronautics and space industries are both major consumers of electronic technologies and attract industrial electronics companies such as Thomson and Matra Datasystems, as well as sustaining numerous software companies. This productive infrastructure is fed by flows of engineers trained

[5] We can see the same type of local development by the use of biotechnologies, in particular genomics. The French government plans to build up a dozen of local platform areas called "genopole" in Evry near Paris, Marseille, Monpelier, Strasboug or Lille…

by engineering schools such as the Ecole nationale supérieure de l'aéronautique as well as scientific universities.

The third centre, in the Bretagne region, is organised around digital telecommunications technology (IT, telecommunications and networks). This region has several engineering schools and universities specialised in telecommunications (Ecole Nationale Supérieure de Télécommunication etc.), from which 600 engineers, 950 higher-level technicians and 250 Bac+5 level university students graduate annually. This area attracts numerous small and medium-sized high-technology enterprises and large corporations such as Alcatel, ATT, Matra, Canon and Thomson multimedia, as well as 4,000 researchers in public-sector institutions such as CNET (National Centre of Telecommunications Research), INRIA. In all, a major part of French research in telecommunications is concentrated in the Bretagne region.

The fourth centre, Sophia-Antipolis, in the Nice region, was one of the first prototypes of the now-familiar science park (Longhi 1999). Built in a region with no industrial tradition in 1970s, its aim, from the outset, was to bring together R&D activities, by favouring the strategic partnership between public research or university labs and corporate labs. It is currently home to 1100 firms of which 25 % belong to IT sector, mostly small and medium-sized technological or research firm, employing more than 2,000 IT engineers and researchers. Although this centre is not exclusively devoted to electronic activities, the sector is well represented by public establishments such as the Ecole de Mines, University of Nice and CNRS, INRIA labs with 1400 students in computer science or telecommunication, as well as research centres belonging to multinational groups such as Nortel networks, SAP, Lucent technologies, or Compaq. This district is also characterised by the historical presence of academic spin-offs from the public institutions. For example, INRIA-Sophia has created one of first spin-offs such as Simulog or Ilog in the fields of computer modelling in 1980s and now continues to create the high technology small companies such as Istar in the digital mapping database, Realviz in computer vision, Focus Imaging in the computer-aided medical analysis.

Three examples of local R&D co-operation between Science and Industry[7]

[6] In terms of scientific/technological activities (academic publications and patents application), Paris is ranked as the most active region in Europe, Grenoble at 31st place and Toulouse at 56th place. Source: Science and Technology 2000, OST (Observatory of Science and Technology).

[7] Each case study was done in the framework of European project SESI co-ordinated by Eric Verdier. Contract:SOE1-CT97-1054

A) Grenoble region

If all the various aspects of its intellectual activities are taken into account -the number of researchers employed, the concentration of higher education institutions and research laboratories, and the number of innovative firms- Grenoble can very properly be described as a "technological district" in the generally accepted sense of the term (Bernardy de Sigoyer et Boisgontier 1988, Salais and Storper 1997), although in reality this city (250000 pop.) has three administratively distinguished scientific parks.

This region has a long tradition of co-operation between industry and higher education in innovation networks, which emerged in the electrical engineering industry in the 1930s. The exchange of know-how and local synergies was maintained in the electro-chemical industry until the advent of the micro-electronics industry in the 1970s. It is undeniable that the Grenoble region had already hosted co-operation between local productive actors which would justify the title of "technological district", or local innovation system. It was against this background that IT emerged from the 1970s onwards, and the infrastructure was renewed around a few dominant establishments such as CNET, LETI (Laboratory of Microelectronics) and Thomson-CSF in the area of semi-conductors, and INRIA, Bull, Hewlett-Packard and XEROX in the IT sphere. At the same time, a large number of small high-tech companies were created, principally as a result of the decentralisation of research centres.

The Grenoble region therefore constitutes an interesting case of an IT industrial district. For our purposes, however, we will try to describe, by way of illustration, the institutional landscape in Grenoble, and its multiple networks of co-operation between industry and higher education.

With regard to higher education, the region has a scientific university and the INPG (National Polytechnic Institute of Grenoble), which is a public federation of nine engineering schools, over thirty research institutes and a doctoral programme. This federal structure accommodates a total of three thousand engineering science students, producing some three hundred doctoral theses per year. In particular, ENSIMAG (Higher National School of IT and Applied Mathematics), a pioneer in IT education, plays a central role in the specialised education of computer scientists (500 students), with symbiotic links between education and research involving the IMAG (Grenoble Institute of IT and Applied Maths) institution. With regard to IT research, there are seven research institutes situated on the university campus under the IMAG label and jointly administered by the CNRS, INPG and the Scientific University of Grenoble. IMAG combines the functions of scientific research, teaching in the engineering school and

university and the supervision of doctoral students. Its seven institutes vary in size, containing between thirty and one hundred staff members; each brings together several teams working on concrete topics such as multimedia systems, real-time programming, parallel calculation, computer assisted translation, and so on. The federal structure allows teams to share resources (IT resources, media library, management, etc.), to participate in decision making and to deal more effectively with external partners. Most of these institutes work at the interface between theoretical and applied fields, and have contacts not only with other public research establishments (CNET, INRIA) and foreign universities, but also with firms. With these different partners, they are capable of developing co-operative networks over time. Collaboration with enterprises ranges from sub-contracting to the joint development of software packages and supervision of doctoral theses (through jointly funded scholarships), and so on.

With regard to public-sector research, INRIA has a research institute in Grenoble with some 230 people. INRIA, one of the smallest public institutions of research with 715 permanent posts is charged with the tasks of developing a centre of scientific excellence in the area of IT, identifying future IT needs and rapidly diffusing its scientific results in partnership with companies. To these ends, it has five research establishments across France, and a budget (in 1997) of 495 billion francs, of which 81 billion, or around a sixth, consist of 360 contracts with external partners. These are predominantly industrial contracts with companies (40%) and European contracts in the Esprit framework (one-third). It occupies 2,100 people, of which 1,700 are scientists (715 permanent posts, 550 doctoral students/researchers, 650 foreign visitors, and 400 external collaborators from industry or higher education). Unlike the other public research institutions, it historically supports the policy of academic spin-offs; in 1997, thirty-seven start-ups generated a combined turnover of 480 billion francs and had 860 employees, either by directly exploiting INRIA licences or prototypes, or by industrialising products in association with INRIA's own researchers. Additionally, the institution has just created a subsidiary, “INRIA-Transfert”, a consultancy which aims to support the foundation of new IT companies and also “I-Source” which is the first institutional venture-capital dedicated to IT start-ups.

The Grenoble institute has 230 researchers, of which around 100 are doctoral students working on the joint projects with the IMAG Institute mentioned above. In 1997, the Institute was working on nine projects, mostly with external partners, in the following areas:

- Communications IT (networks, Internet, systems and applications). Projects in this area involve a significant degree of partnership with firms such as Bull, Rank Xerox, SGS-Thomson, Aerospatiale, Hewlett-Packard, and others.

- Intelligent machines (digital imaging, intelligent vehicles). These involve strong collaborative relationships with EDF (Electricité de France), Renault, CNET, and others.

- Parallel calculation (basic software and intensive calculation). These involve partnerships with software and IT service companies such as Simulog and Matra Cap Systèmes.

Despite all these projects, the Institute has only 70 of its own researchers, who work with around 100 doctoral researchers and around 60 outside partners. It is thus heavily dependent on external resources supplied by the local infrastructure. It co-operates strongly with Bull (which has a research centre in Grenoble) in a "grouping of economic interest" which jointly manages four programmes. Through this relationship, the Institute is permanent host to around ten Bull engineers. This partnership is, in great part, the inheritance of long-established collaboration between Bull's scientific department and the local scientific community (particularly IMAG). INRIA has increasingly become the main catalyst in the process of turning scientific findings into concrete applications.

B) Bretagne-Atalante region

Bretagne-Atalante is one of the leading areas in France for telecommunications. Ever since the region's development plan led to the establishment in the 1960s of CNET, a research centre affiliated to France Télécom, and the founding in 1974 of Transpac, a subsidiary of France Télécom operating in the field of data transmission, Bretagne-Atalante has been at the heart of technological developments in the telecommunications field. Over the course of time, the region has succeeded in building on the foundations laid by these public-sector establishments and has now accumulated considerable scientific and manufacturing capacities (Le Bourdonnec 1996). It can now boast research institutes and higher education establishments, high-tech companies and technology transfer facilities. Thus three sites close to university campuses and other scientific research centres have been developed to accommodate high-tech firms. The Brest site, based around Thomson, Alcatel and the University of Brittany, has 5,000 workers, including 1,000 engineers. The second site, at Lannion, has 6,000 workers, including 3,000 engineers, employed by Alcatel, Lucent Technologies, Siemens and a number of software houses, such as Sema Group, Cap Gemini and Cégétel. The Atalante site, for its part, has 7,800 workers, including 3,000 engineers, employed by Matra-Nortel, Thomson-Multimedia, Lucent Technologies, Mitubishi Electric ITE, Transpac, Wandel and Goltermann CTS, as well as many small firms that together employ 3,800 people. On the other hand, the 4,300 people employed in the telecommunications field are dispersed among mainly public-sector laboratories affiliated

to organisations such as the University of Rennes, CNET, Ccett, CNRS, Ecole Nationale Supérieure de Télécommunication de Bretagne (ENST), INRIA etc. Also worthy of mention is the extensive higher-education infrastructure, which includes *grandes écoles* such as ENST, the Ecole Supérieure d'Electricité and ENNSAT and university institutes such as INSA etc. Each year, these higher-education establishments produce 1800 specialists (600 engineers, 950 advanced technicians and 250 graduates with five years' higher education) in the fields of information technology, telecommunications and networks. Thus this region accounts for between 40-45% of the French research potential in telecommunications. This close proximity between firms, research institutes and higher-education establishments, and the intense exchanges of information and knowledge it fosters, has made Brittany one of the most attractive regions for multinational companies.

C) Sophia-Antipolis, Nice region[8]

This science park has developed in a particular context relative to other sites of this kind, notably Oxford. When the district was created, Sophia Antipolis was a "vacant space" in the sense that the site had no existing activities. The conditions of collective learning that might allow the development of a localised innovative environment (Salais and Storper 1997) were far from being fulfilled: the environs of the site offered neither basic industrial knowledge and expertise nor a tradition of business start-up nor the presence of universities or research centres. The local transportation system was also minimal, but the region offered the advantages of a good climate and a potential for tourism. The twenty-five years of the science park's existence may be broken down into three periods (Longhi and Quéré 1999, Longhi 1999):

- The 1980s corresponded to a growth period that saw massive arrivals. The district was created at the end of 1970 on the basis of the public authorities' decision to relocate certain activities coinciding with the confirmation of the region's advantages on the part of the multinationals, mainly American. In the context of the globalisation of that period, these firms saw Sophia Antipolis as a base of implantation that would allow them to adapt their products to the European markets. In order to encourage them in this direction, public research laboratories were relocated to the area, notably the CNRS in 1976 and INRIA in 1982, as well as certain departments of the Ecole des Mines (National School of Mining Engineering in Paris) in 1976.

[8] See in detail : Lanciano-Morandatt Caroline, Nohara Hiroatsu, « Les essaimages académiques dans le secteur de l'informatique en France : Effets institutionnels, effets de territoire ou construction des acteurs locaux ? », *Revue d'Économie Régionale & Urbaine*, 2003/2 (avril), p. 235-265.

The University of Nice Sophia-Antipolis (UNSA), founded in 1969, settled on the site much later, in 1986. By 1989, there were 672 companies on the site, accounting for the creation of 11,257 jobs, mainly in the new information and communications technologies.

- The early 1990s marked a difficult transition period. In response to the world-wide crisis (especially in computers) and the supremacy of the large companies, the firms being created or installed in Sophia did so without major financial investments or transfers of human resources. Smaller in size, they tended to rely on the use of particular features or local potential (partly created during the previous period) for more limited markets. Whereas during the earlier period the majority of the companies had relations outside the site, especially at of large firms and service companies. Between 1990 and 1995, the rate of company installations and creation of jobs dropped off sharply[9].

During these two periods, growth was essentially exogenous international level, the 1990s saw the growing importance of local networks (around 80 %), with significant numbers of relocations to Sophia, and the jobs created were basically centred on services to large businesses. The local labour market was limited and had not yet permitted "the emergence of a local process of collective learning".

- The 1996-1997 period may be described as years of crisis, rapidly followed by recovery. In order to counter a certain stagnation, the site's different actors magnified the crisis, which allowed them to mobilise internal resources and get the district's development process going again. New institutions of higher learning were created (CERAM, a business school, Eurécom, etc.). The activity of employers' associations in favour of business start-up had begun to have positive results and the linkages between the HERS and the business sector led to a few “success stories”. Growth then became endogenous (around 75 %), with the beginning of business start-up, especially in the ICTs, on the basis of the local production fabric, notably through the research bodies and higher education institutions. A relatively active labour market emerged at local level as the HERS began supplying recent graduates trained on the site. The joint learning experiences, resulting from ties that had previously been developed between the companies and the various institutions started bearing their first fruits.

[9] Forty-nine companies arriving annually as compared to 78 during the previous period, with an average of 652 jobs created as compared to 1,080.

The 'scientific district', dominated twenty-five years ago by multinational subsidiaries, was thus transformed into a science park sustained by a “localised innovative environment” that is favourable to business start-up and with numerous SMEs[10].

More concretely, the creation of this district began as an effort for the relocation of “brains or grey matter” initiated by the DATAR (France's regional planning authority) in the context of the development projects of the sixth “Plan”. ("Sophia, child of the DATAR," is how the DATAR's director described it in a special issue of Journal *Nice Matin* devoted to the site in June 1999.) The installations of the CNRS and Ecole des Mines labs, like those of INRIA and the UNSA several years later, took place in this context. The prefect was in charge of the material realisation of decisions made in Paris. In order to attract the large international companies, national (and often nationalised) corporations were encouraged to relocate some of their subsidiaries (Air France, Thomson Sintra, the creation of Télécom Valley). During the second period, by contrast, the public actors were less present, which led in particular to a delay in the improvement of the local transportation system. The effects of investments made during the previous period were not yet felt, and it was only at the end of 1998 that students and researchers were present in large numbers (2,000 students and 1,800 public researchers, engineers and technicians). the State intervened with new public investments, notably for the creation of schools and universities. But local communities were later to be involved in the management of the site as well. From the outset, the action of the public authorities was orientated towards the development of streams linked to the NTIC, and later in the health sector as well (implantation of the CNRS and Inserm labs), which led to the specialisation of the technopôle.

The successive public interventions in the development of this science park proved to be decisive in forging its trajectory and ultimately its present shape. The public authorities thus seem to have played an essential role in setting up this district in comparison with those in the UK or the US.

At the same time, some semi-public actors emerged as mediators between the worlds of politics and business, to encouraging public action; each one made a particular contribution to the present scheme. These actors thus helped to enliven the science park in various ways, notably through the creation of numerous associations. The science park's mediators are many and varied,

[10] These SMEs (300 or less) account for 50 % of the companies and 30 % of the jobs (source: SAEM).

including a multitude of associations or clubs (e.g., Fondation Sophia Antinopolis, Respublica, Télécom Valley, High Tech and Persan)[11]. Their double mission consists of initiating collective activities and relations between the district's " productive " actors (Firms, Public Laboratories, Training institutions) on the one hand and representing them on the other. These actors are often in competition with one another and as a result, constitute a politico-economic network (Callon 1991) that is extremely complex.

At the time of the site's creation, the main activity of these actors was administering the district as a real estate holding and ensuring its profitability, as well as seeking out new clients likely to settle there. They were grouped together in many distinct and competing organisations, which made their appearance confusing for newcomers. The "big" crisis of 1997 brought out this ambiguity between their different roles and led to the creation of a "revival charter" signed the same year. Negotiated between them and specifying the roles of each one, it distinguished site development policy, real estate management and prospecting for new clients.

In recent years, however, new kinds of associations have emerged, devoted on the one hand to projects of site expansion and on the other to activities encouraging and assisting business start-ups (the different start-up clubs, 3 projects for private incubators on the site). The controversies and power struggles between mediators have been revived, which has once again made the science park's resources somewhat obscure for future entrepreneurs.

Overall, the Sophia Antipolis science park is in a paradoxical situation. Initially, the region had no industrial or university tradition, and the site was strategically administered from the outside (public authorities in Paris, multinationals), with its property run by local intermediate associations. Relations between industry and the universities/national labs were long in coming, but the development of a fabric of SMEs stemming in part from the large companies (outsourcing and services), the multiplicity of informal relations and the context of conflicts and competition between the associations have created a competitive spirit among the 'productive' actors which has gradually been transformed into an "innovative milieu" as the collective learning capacity of the different actors has been materialised. The science park environment has thus given rise to a certain kind of "culture" which allows the socialisation of the productive actors to the highly competitive context of the hi-tech sector. Nonetheless, this

[11] Télécom Valley is a kind of club made up of large corporations; Persan is the club of the research and educational institutions.

environment remains quite opaque in systems of incentives and aid that it offers to business founders.

As far as the specific influence of INRIA is concerned, it's arrival on the Sophia Antinopolis site provided a strong incentive for other public laboratories and the companies. Since then, the institute's technology transfer policy, implemented at both national and local level, has contributed to getting Sophia's innovative environment going. INRIA has helped to give a scientific and technical legitimacy to the district, to endow it with the image of a science park when, at the outset, it did not have the requisite features. The presence of the public body specialised in computer science helped to attract firms linked to information and communications technologies and to get the site involved in this kind of activity. This image was reinforced by the arrival of internationally recognised research teams and some of its "success stories" that were useful for promoting the site. At present, its activity is aimed both at creating new ties and maintaining existing ones. On the site, various contracts have allowed it to enter into contact with major corporations and mechanisms to assist business start-up have allowed it to constitute a network of INRIA's spin-offs. This network is maintained through formal and informal relations between these companies and, on the one hand, the development actors/facilitators (incubation, management consulting, systematic scientific meetings, etc.) and on the other, the teams from which they originate. The movements of researchers or doctoral candidates from INRIA towards these companies, as well as the researchers' involvement in local university teaching, also play an active role in the transfer of knowledge, as do the different internships proposed to students. This network is thus one of the pillars of the on-site "innovative environment" and, notably through the emergence of a local labour market, contributes to its dynamism. Nonetheless, if we look carefully at relations between INRIA's project teams and the science park, we observe that the flows of knowledge are not necessarily continuous and that the technology transfers, which are fairly sporadic, depend on the teams or, more precisely, on the nature of their research, and that for the majority of INRIA's teams, the essential linkages lie outside the district.

*

The brief outline of these cases should only be seen as an illustration and has no pretensions to representativeness at the French national level. However, it provides us with deep insights into certain innovative dynamism located at "technopôles".

Bibliography

Aoki, M. (1988). *Information, incentives and bargaining in the Japanese economy*. Cambridge, Cambridge University Press.

Becattini, G. (1990). The Marshallian industrial district as a socio-economic notion. *In* F. Pyke and W. Sengenberger

Becattini, G. (1991). The industrial district as a creative milieu. *Industrial change and regional development: the transformation of new industrial spaces*. G. Benko and M. Dunford. (London and New York: Belhaven Press**:** 102-114).

Berger, S. and M. J. Piore (1980). *Dualism and Discontinuity in Industrial Societies*. Cambridge, MA, Cambridge University Press.

Brusco, S. (1986). Small firms and industrial districts. The experience of Italy. *New Firms and Regional Development in Europe*. D. Keeble et al.(ed.) (London: Croom Helm)

Cohen, E. (1992). *Le Colbertisme High-Tech. Economie des Telecom et du grand projet*. Paris, Hachette.

Crozier, M. (1964). *Le phénomène bureaucratique*. Paris, Le Seuil.

Hancké, B. (1996). *Industrial Reorganisation in France: Changing relationships between large and small firms.* Wissenschaftszentrum Berlin für Sozialforschung, Discussion Paper FS I 96-301.

Lanciano-Morandatt, C. and Nohara H. (2003). *Les essaimages académiques dans le secteur de l'informatique en France : Effets institutionnels, effets de territoire ou construction des acteurs locaux ?* , **Revue d'Économie Régionale & Urbaine, 2003/2 (avril), p. 235-265.**

Le Bourdonnec, Y. (1996). *Le Miracle Breton*. Paris, Calmann-Lévy.

Maurice, M., F. Sellier, Silvestre JJ. (1986). The Search for a Societal Effect in the Production of Company Hierarchy: A Comparison of France and Germany, Cambridge MA: MIT-Press.

Sabel, C. F. (1993). Studied trust. Building new forms of cooperation in a volatile economy. *Technology and the Wealth of Nations. The Dynamics of Constructed Advantage*. D. Foray and C. Freeman. (London, New York: Pinter Publishers**)**.

Saglio, J. (1995). Industrial Relations and Human Resources in France. *Employment Relations in a Changing World Economy*. R. Locke, T. Kochan and M. Piore. (Cambridge, MA: MIT Press**)**.

Longhi, C (2000). *Networks, Collective Learning and Technology Development in Innovative High Technology Regions: the Case of Sophia-Antipolis*, **Regional Studies, Vol.33.4, pp.333-342.**

Nelson, R. (1993). *National Innovation Systems*, Oxford University Press, New York.

Nohara, H and Verdier E. (2001). *Sources of resilience in the Computer and Software industries in France.* **Industry and Innovation, Vol.8, Number 2, pp201-220**.

OST (Observatory of Science and Technology). (2000). Figures of Science and Technology 2000, 463pages, Paris.

Salais, R. and Storper, M. (1997). *Worlds of Production: The Action Frameworks of the Economy,* Cambridge, Mass.: Harvard University Press.

Soskice, D. W. (1996). *Technology Policy and National Institutional Frameworks: the UK and Germany*. CEPR Conference on European Industrial Policy, Wissenschaftszentrum Berlin für Sozialforschung.

Veltz, P. (1996). *Mondialisation, villes et territoires. L'économie d'archipel*. Paris, Presses Universitaires de France.