The genesis of two urban innovation systems in France : Grenoble and Toulouse.

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ABSTRACT

Grenoble and Toulouse are the leading french urban innovation systems outside Paris. This paper analyses their genesis. Their story has two different sides : the scientific one and the industrial one. The scientific histories of the two towns are very similar since the creation of electrical institutes in the beginning of this century, but their industrial histories are very different. In Grenoble, science-based industry is very ancient and is from a long time connected with universities and science organizations. In Toulouse, science-based industry is the result of national policies and its connection with universities and laboratories came much later. Despite this difference, the two urban innovation systems are very similar now.

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URBAN INNOVATION SYSTEMS

What is a regional innovation system ? There are two possible ways to define it. The first one starts from the national level and is a transposition of the notion of national innovation system (Lundvall, 1992) to the regional level. In this view, a regional innovation system should be a consistant set of firms, research organizations and political institutions linked together. The second possible way is, on the contrary, to start from the local level, industrial districts (Beccatini) or

1This paper is mainly based on *Science, industrie et territoire*, Presses Universitaires du Mirail, Toulouse, 1995, by Michel Grossetti

technological districts (Saxenian, 1989), local innovation systems (Gilly and Grossetti, 1993, Grossetti, 1998). In this second view, a regional innovation system should be a set of firms and research organizations with a partly free exchange of information between organizations. National and local innovation systems exist. Regional political leaders would like the regional innovation systems to exist. If these systems should exist one day, they should be somewhere at the crossroad between national and local innovation systems.

Among the questions about these new kind of innovation systems, the question of the policies' impact on the making of regional innovation system is a key one. How far regional policies can contribute to the making of a regional innovation system ? One possible way to discuss this question is to examine the way that local policies had contributed in the past to the emergence of local innovation systems. This is why I will illustrate in this paper with the example of two local innovation systems in France, a country where there is no real regional innovation system yet. In France, the universities, the research organizations and the main industrial firms with R&D activities are concentrated in the Paris area and in provincial towns. Except for the Paris' region, the main infra-national level for innovation systems is the urban area. Almost 80% of laboratories and 60% of firms cooperating with them are located in regional capitals. Outside Paris, ten provincial towns concentrate the greatest part of scientific and technological resources : Lille, Strasbourg, Nancy, Grenoble, Lyon, Marseille, Montpellier, Toulouse, Bordeaux and Rennes. The concentration is also very important for firms : in 18 of the 22 french regions, 60% of the firms that have contracts with laboratories from Centre National de la Recherche Scientifique (CNRS) are in the regional capital urban area. In the few regions where there are two big towns with important universities (Rhone-Alpes with Lyon and Grenoble for example), there are very few links between laboratories from one town and firms from the other town.

Grenoble and Toulouse are by far the leading provincial urban areas for cooperations between universities or research organizations and firms. Between 1987 and 1997, CNRS laboratories signed about 14000 research contracts with firms. A great part of these contracts are signed with Parisian firms because Paris region concentrates the major part of french industrial R&D. Outside Paris, more than half of the contracts are signed with firms from the urban area of the laboratory : they are indicators of local relations between firms and laboratories. Laboratories from Paris region signed almost 25% of these contracts ; those of

Grenoble and Toulouse 12% each, those of Lyon 10%, and the laboratories from other big universitary towns (Montpellier, Nancy, Bordeaux, Marseille, etc.) all between 4% and 5%. Grenoble and Toulouse come also at the first place after Paris' region for the number of firms created by members from laboratories with 9% each (Grossetti, 1995, secondary analysis of data from Mustar, 1995).

The Parisian region apart, Grenoble and Toulouse are the most important urban innovation systems in France. The two urban areas share two important characteristics : a lot of laboratories and researchers in engineering sciences and firms with R&D activities, in electronics and computing in Grenoble, aircraft engineering, satellites and electronics in Toulouse.

Mainly based on some specific historical works (Grossetti, 1995, Grossetti *et alii*, 1996) this paper aims to analyse the historical formation of these two urban innovation systems. They have a very similar scientific story and a very different industrial story which are converging after 1975. Although focussing on Grenoble and Toulouse, the paper will give an insight on the the main historical steps of the formation of french urban innovation systems in general.

1. BEFORE 1900 : TWO TOWNS WITH A UNIVERSITY NEAR MOUNTAINS

1.1.National context

From 1793 to 1896, France had no universities. After the revolution of 1789, France was divided into " academies ". Each academic centre oversaw several Faculties, as well as the organization of the " baccalauréat ", principal component of the French educational system. At the same time the dualism of the system was put in on long-term basis, with, on one hand, the faculties that were not much active until 1870, and on the other hand institutions having a unique status, such as the engineering schools and resarch institutes (" Collège de France ", " Académie des Sciences ", etc.).

As for the *grandes écoles* , some have been created before the Revolution, in response to the needs of the State (" École du génie à Mézières " (1748), " École des ponts-et-chaussées " (1755), " École des mines " (1783)). Founded during the Revolution, the " École polytechnique " and the " École normale supérieure " became the core of the system with the " École centrale des arts et

manufactures ” opening in 1829. Most scientists of this era trained at these schools. Research was separate from the higher education and concentrated in institutions like the “ Collège de France ” (created in 1530), the “ Jardin des plantes ” (1636), the “ Observatoire de l'Académie des sciences ” (1672), the “ Museum d'Histoire Naturelle ” or the “ École pratique des hautes études ” (1868). Decentralisation of schools and research institutes was nonexistant, and most of the important institutions remained in Paris.

At the beginning, the Faculties were few in number (in 1808 only five towns had Faculties of Science : Paris, Toulouse, Caen, Montpellier and Strasbourg), but the problems of “ baccalauréat ” organization and the temptation to increase the number of students in order to increase the income from the examination, led governments to open new faculties during the ‘Second Empire’ period, until one of each kind existed in every academic centre.

Since the budget given by the State was increasing very little, the increase in the number of Faculties resulted in a dispersion of resources, later much criticized. Geographically, a first stage of structuring was carried out during this period : the constitution of the academic centres (Nancy rather than Metz, Rennes rather than Nantes, etc.), which had had long term effects upon the development of university towns, the academic centres of this time now having become the most important universities.

The imbalance between Paris and the rest of the country was very important. Because of the proximity of the “ École normale supérieure ” , the Parisian faculties had a number of true students. Because of the *grandes écoles* and the research institutes, the professors could gain additional income and participate in the intellectual life of the time. Part of their salary depended on the number of students, making Parisian professors far wealthier than their colleagues from other towns. Paris’ faculties also had most professorial positions, because more than half of France's students were enrolled there (Prost, 1968). The number of professor positions in other academic centres did not depend on the number of students or “ baccalauréat ” candidates ; a faculty of letters had generally only 4 or 5 professors, and a faculty of science 6 or 7.

1.2. Grenoble and Toulouse

The main task of teachers in provincial faculties was to organize the "baccalaureat". Sometimes, they did some research, but they had very poor resources for it. Nevertheless, during that period, a durable map of the french scientific system was constructed : the 15 academic centres of 1854 remain almost unchanged until 1945. Toulouse and Grenoble were two of them with faculties of science created in 1808 (Toulouse) and 1854 (Grenoble).

During the XIXe century, Grenoble was a growing industrial town first with glove factories and later on with cement works. Toulouse was only a big administrative capital of a rural region with no significative industry. From 1860, Grenoble became the center of the development of the french hydroelectric industry, with the first high waterfall equipment. At the end of the century, hydroelectric industry is already a local innovation system with a set of firms linked together, but without any support from university.

2. 1900-1914 : THE CHOICE OF ELECTRICAL ENGINEERING, A SAME BIFURCATION FOR DIFFERENT REASONS : INDUSTRY IN GRENOBLE, LOCAL POLICIES IN TOULOUSE

2.1. National context

The defeat of 1870, the institution of the Third Republic and the coming to power of the Republicans from 1876 resulted in a strong disruption of French society particularly in higher education. The massive effort for education, the reforms in higher education and, above all, the relative autonomy given to the faculties and to local actors, resulted in an important differentiation of the science poles. The system of 1808, barely modified until 1870, was criticized more and more strongly beginning in the middle of the century, particularly by academics aware of the development of German and British universities. These critics came behind the reforms which began at this time[2].

G. Weisz (1977) mentions numerous reform projects, with the creation of

2 The movement to reform the higher education began in the middle of the century, becoming institutionalized in 1878 with the creation of the "Société pour l'étude des questions d'enseignement supérieur", numbering 514 members in 1880. This organization boasted fewer Parisian professors than those from other faculties (Weisz notes that only 12 Parisian professors out of 88 were members versus 126 professors from other towns out of 323). Since 1881, this organization had been publishing the "Revue internationale de l'enseignement" with articles about the condition of French higher education and the situation in the other countries, particularly in Germany.

universities being more a federative slogan than a well defined project. Most reformers agreed with the idea of creating few complete universities (where all the disciplines would have been taught) and of giving these universities a certain autonomy in order to collect local funds because the State could not afford an important financial effort at this time.

Most of the republicans also shared the reformers' ideas because some of them were themselves professors. So, when the republicans assumed power in 1876, the reforms got underway quickly.
The first decisions aimed to solve the most urgent problems : to recruit students for the faculties and make them work. The decree of November 3rd, 1877 created 300 grants for " licence " students, the October 1st 1880 decree 230 grants for " agrégation " students. The greatest part of these grants were attributed to students outside Paris (83% of the licence grants, 65% of the " agrégation " grants). Also, the ministry of Education answered the town administrations to renovate faculties premises or to build new ones. The State made an important financial effort : faculty funds more than doubled between 1875 and 1885, the state part increasing from 41% to 74% (Karady, 1986). It was also necessary to reform the teaching organization. Several decrees reorganized the "licence", creating new courses, requiring the *agrégation* students to attend faculty courses, etc.

Reforming the educational structure proved to be more difficult. The consensus between the reformers concerned only generic principles. But, when it came to reorganizing the system in concrete terms, every one championed its own organization, town and corporation. In 1883, Jules Ferry consulted the faculties about the future universities. The responses showed that consensus was limited to the creation of universities and to the principle of independance *vis-a-vis* the central administration.

The legislative effort focussed on the question of administrative autonomy, particularly with the decrees of July 25 1885, which allowed faculties the right to their own properties and to receive funds from local autorities. Other decrees organized the management of the faculties, giving professors the major decisional power, allowing the faculties to have their own budget. The project of creating a few large university centres resulted in competition between the towns. They were asked to modernize their buildings, and, from 1885 on, they were autorized to underwrite new courses, with the idea that those towns which had made the

most effort would obtain their own universities. Furthermore, republicans came to power in many towns where they provided efficient support for the government action. Because they were authorized to finance new courses or buildings, manufacturers and scholarly societies became involved in university issues, putting pressure on the town authorities. Thus, the towns made an important effort, mainly to renovate universities premises, and, more rarely, to create new courses. Grelon notes that, from 1868 to 1878, town councils gave 27 millions francs, general councils 600,000 francs and the state 12,9 millions francs for the reconstruction of universities buildings. From 1879 to 1883, the respective contributions were 22,9 million francs, 200,000 and 18,7 millions francs.

In the end, this competition resulted in the equality of the entrants. Prost (1968) showed that the government could not really create 4 or 5 large universities, because every town or region with a faculty wanted to create a university from it. In fact, from 1890, the senate, which was dominated by local interests, brought to a halt all legislative proposals that would have selected among the university towns, and asked for the establishment of a university in every academic centre.

This conception prevailed. First, faculties in a same town were joined into faculties groups (1883) that took the name of universities, in accordance with the law of July 10 1896. The decree of the July 21 1897 authorized the universities to create their own specific diplomas.

This decree provided a legal framework to another aspect of the competition between the towns, which in turn had very important effects on the differentiation of universities : the creation of applied institutes in the faculties of science. The competition for the creation of new courses had begun in the early 1880's with the chemical institutes of Lyon (1883) and Nancy (1889), and it was spreading by the end of the century. In most of the academic centres, new courses were created, often beginning as opened evening classes and forming new institutes that found their definitive organization with the decree of 1897.

Local industrial specificities explain the creation of new courses in chronometry in Besançon, œnology in Dijon, etc. Higher education in the field of agriculture was also organized[3]. It was often said that the applied institutes were mainly created in

3 Applied institutes in agriculture in Nancy (1901), Alger (1905), Toulouse (1909), œnology in Dijon (1902), brewing industry school in Nancy (1893) were added to the national schools of Grandjouan and La Saulsaie, transferred respectively to Montpellier (1872) and Rennes (1896), and the new schools of Versailles (1873) and Douai (1893)

two new technical fields : electrical engineering and chemistry. When the facts are examined, it appears that while chemistry was often chosen[4], a few faculties only had been interested in electrical engineering[5] (Grelon, 1989).

Local efforts had different orientations : future big centres for chemistry arose at this time in Lyon, Montpellier, Bordeaux or Toulouse, while the electrical engineering institutes formed the basis for the development of engineering. Above all, these efforts differed in intensity : 5 institutes or schools were created in Nancy, 3 in Toulouse, but only one in most of the academic centres. The applied institutes differed in size. Burney (1989) notes that 80% of all the holders of applied science diplomas in 1913 were from Toulouse, Grenoble and Nancy, and that in the faculties of science of these three towns, 60% of the students were registred in applied science courses. This situation mainly resulted from the strong development of electrical engineering institutes.

4 Institutes of Lyon (1883), Bordeaux (1891), Montpellier (1908), Toulouse (1906), Nancy (1887), Caen (1914), Clermont-Ferrand (1913), Lille (1894), Paris (1896), Besançon (1920)
5 Institutes of Grenoble (1901), Nancy (1900) et Toulouse (1907), Lille (1925) and, later, Institute of dioelectricity in Bordeaux (1920)

2.2. Electrical institutes - Grenoble and Toulouse

The “institut d’electrotechnique” of Lille has not been successful because of World War I. However, the institutes of Grenoble, Toulouse and Nancy were a success. We still can see the consequences of this bifurcation : in 1999, Grenoble, Toulouse and Nancy are the leading provincial centres for engineering sciences and engineers’ training.

The contexts of the creation of the three institutes were very different.

In Grenoble, the hydroelectric industry was expanding quickly when Casimir Brenier, head of the Chamber of Commerce ” (the local union of manufacturers) asked the faculty of science to open an electrical engineering course and started a fund for it. Casimir Brenier was himself the manager of a manufacture of equipement for the hydroelectric industry. The town council decided to finance a part of this course that was opened by the faculty, which created at the same time a laboratory in electrical engineering. The course and the laboratory formed the “ institut d'électrotechnique ” which began to work on the premises of a high school. The July 4 1898, the university decided that “ *the greatest part of university resources will be devoted to the development of electrical engineering teaching* ”. On April 27 1900 a "Société pour le développement de l'enseignement technique près de l'Université de Grenoble" (Society for the development of technical teaching in Grenoble university) was created by the manufacturers. The institute was now working. Later, Brenier donated a 5000 m2 site were the institute built its premises.

In Nancy, the institute of chemistry was strongly financed by the Belgium firm Solvay, owner of manufacture near the town (on the Dombasle site). The town gave the land and 500,000 francs collected. The *Conseil Général* of Meurthe and Moselle gave 100,000 francs, the *Conseil Général* of Vosges 10,000 francs. A fund was started to aid the creation of the electrical engineering institute and received a big gift from A. Solvay, which wanted to get political help in using local mines of salt. (Birck, 1998). The town gave lands again, the *conseils généraux* some funds, and the new institute was able to open in 1900 almost without any help from the State.

In Toulouse, the socialists took over in the town council in 1906 (they remained in power until 1908) and proposed to finance a Chair in electrical engineering. The

mayor justified it in these terms : " *The town council made this wish in order that a lot of young workers can take advantage of the work created in Toulouse by the power that will be harnessed in the Pyrénées. We hope that our town will become an industrial centre because of the hydroelectric power, and it is good to prepare a number of workers for that*" (Bulletin municipal, 1906, p.206). The town " *promises to finance the wages for the electrical engineering chair (6000 francs) and for the assistant job (3000 francs) (…) The present agreement will be operative for twenty years beginning November 1st 1907*". The town also gave premises but lowered the yearly fund given to the university from 20000 to 15000 francs.

Economic, political, social, academic logics, every aspect of the local dimension influenced the universities' reorganization and the creation of the institutes of applied science. A geographical differentiation had begun. The fact that reformers did not succeed in their wish to select a few towns to house universities meant that the previous territorial homogeneity would remain : one university town per academy. The faculties of letters, law and medicine in the different towns became differenciated from each other because the numbers of students varied or because of the local environment, but they kept similar organizations and courses. On the contrary, the choices made by faculties of science to create the institutes resulted in the first break with the long period of homogeneity with its concentration of the important institutions in Paris. Choosing electrical engineering, faculties of science of Grenoble and Toulouse took a great advantage for the future.

3. 1914-1945 : SCIENCE AND INDUSTRY CONNECTING IN GRENOBLE, NO CONNECTION IN TOULOUSE

3.1. National context

The period between the two world wars was very difficult for most of the faculties' institutes : lack of money, lack of students. Most of them survived only with the help of foreign students (particularly jews from Russia or Roumania). The governments were far less interested in higher education than before the first world war, except for some specific national programs, like in fluid mechanics (Mounier-Kuhn, 1996).

3.2. Grenoble and Toulouse

The institute of Grenoble was in perfect connection with the local industry. Firms used its measuring devices, they hired students coming from the institute, they helped the institute in buying new instruments, etc (Pestre, 1990). From 1919, Merlin-Gerin, an important electrical engineering firm develop with a lot of connections with the electrical institute. The urban innovation system was complete and successful.

In Toulouse, the dream of an industrial development based on hydroelectricity never came true : electrical firms of Grenoble were strong enough to make the hydroelectric equipment of the Pyrenees and the local electrical industry never grew up ; some factories in electrochemistry were settled up in the Pyrenees, but they could not stand the comparison with the industry of the Alpes. The aircraft industry created successfully in Toulouse in 1917 developped without links with faculty institutes. The electrical institute had cooperations with the "Compagnie du Midi" a railway company that produced also electricity and used electricity to power the trains.

4. 1945-1975 : INNOVATION IN GRENOBLE, NATIONAL POLICIES FOR TOULOUSE

4.1. National context

With the end of the second world war began a period when the structures of the country were deeply altered. The reforms made at this time had in common a will for rationalization and homogeneization of situations that the IIIrd Republic had allowed to vary. The research and the higher education did not escape to this movement. New national institutions were created or developed. The " Centre National de la Recherche Scientifique " (CNRS), founded in 1939 in order to catalyze the French research that had been declining between the two world wars[6], became really important only from 1945, with the creation of about thirty laboratories (Picard, 1990). The " Centre National d'Etude des Télécommunications " (CNET) was created in 1944, the " Commissariat à l'Energie Atomique " (CEA) in 1945, the " Institut National de la Recherche

6 French scientists had received 11 Nobel prizes between 1901and 1914, versus 13 given to German scientists. The numbers for the 1918-1939 period were, respectively, 5 and 20.

Agronomique " (INRA) in 1946… During the same time, the institutions that had been created at the beginning of the century were rationalized, and new ones were created by the national state.

On a territorial level, the differentiation that had started at the beginning of the century continued, following two different logics. The first one can be called a spontaneous logic. Institutional and scientific shapes resulted in the strengthening of certain poles when new applied sciences were introduced in France from the United States or Great Britain : chemical engineering, automatics or computing. The second logic was of political kind, resulting from the national and regional development politics that began in the 1950's and strengthened during the 1960's. Several establishments of national research institutions were transferred or created from Paris (CNET in Lannion, CEA in Grenoble, CNES in Toulouse, INRIA in Sophia-Antipolis, etc.). These decisions were made according to criteria that were either " technical " (to minimize the cost and the difficulties of the operations, that leads to reinforcing the existing poles) or political (to create new poles). Another evolution of the higher education system can be explained more by teaching issues than by research : the creation of numerous new university establishments in towns that until then had no university (Nice, Nantes, Orléans-Tours, Pau, Perpignan, etc.). The number of university towns doubled between 1945 and 1970[7]. At first, these establishments were limited to the undergradute degrees or to specific courses, but they later became complete universities and formed the basis of the present " satellite " poles linked with the big university centres.

3.2. Grenoble and Toulouse

The new applied disciplines developed first in some towns, particularly those which had created big institutes at the beginning of the century.

Chemical engineering found a place in the French higher education system in 1949 with the creation of the " Institut de génie chimique de Toulouse " and the courses opened a little later in Nancy's " École Nationale Supérieure des Industries Chimiques " (the new name of the old institute of applied chemistry). More than forty years later, Toulouse and Nancy remain the most important

7 The creation of these new universities, which has not much been studied, seems to make an important place to local initiatives despite the centralism of the higher education system of this time.

centres for what is now called " génie des procédés " (process engineering) (Rapport Gaillard, 1991).

Automatics developed first in the electrical engineering departments of Toulouse and Grenoble's institutes, where two laboratories were created : the " Laboratoire de génie électrique de Toulouse " (1955), basis for the future " Laboratoire d'Automatique et d'Analyse des Systèmes " (1967), and the " Laboratoire d'Automatique de Grenoble " (1961). Nancy followed in 1965 with the " Laboratoire d'Électricité et d'Automatisme ". The other French research teams were later created by doctors coming from the precursory centres.

Computing began in France with the arrival of the first commercial computers in 1955. The first faculties of science that were equipped were those where numerical calculation was teached, most of the time because of the needs of electrical engineering schools : Toulouse and Grenoble in 1957, Nancy et Lille in 1961. The first research teams were founded in Grenoble and Toulouse (Grossetti, 1993).

Most of the time, the precursory poles, and among them Grenoble and Toulouse as leaders, maintained an important numerical advantage. In 1991, the members of the CNRS department of the " Sciences Pour l'Ingénieur " were mainly in Paris (27% of the researchers and professors of the department), Grenoble (11%), Toulouse (11%), Marseille (8%) et Nancy (8%), resulting from the differentiation of the 1945 - 1968 period.

Grenoble and Toulouse both benefitted from national policies of regional development with the creation of big research centres for nuclear physics in Grenoble (1955) and for space in Toulouse (1968). Toulouse benefited also of other national decisions in reinforcing its industry.

In Grenoble, after the war, physics research was dominated by the personality of Louis Néel (who win the Nobel prize in 1970), who had created the " Laboratoire d'Electrostatique et de Physique du Métal " (LEPM). The LEPM was well inserted into the local research system, had relations with industry (two firms were created by members of the laboratory) and was growing fast, reaching 100 members in 1954. Néel and his colleagues had obtained important results that led them to seek better equipment. At the same time, the CEA needed to create a new establishment outside Paris (where the government did not want new premises to

be built) and hesitated between Toulouse (where the town council proposed to finance a part of the creation), Strasbourg and Grenoble. After discussions between Néel and the heads of the CEA, the decision was taken to create the " Centre d'Etudes Nucléaires de Grenoble " (CENG), headed by Louis Néel. Recruiting a lot of researchers in Grenoble schools and university, the CENG managed to have 3000 researchers in almost 150 research teams. The CENG is not a transferred establishment. It is more the result of the growth of pre-existing research team, strongly sped up by the CEA's budget.

The case of Toulouse, where the most important operation took place, is intermediary betweeen "technical" and "political" moods : the decision was reputed " technical " but had never really been seriously discussed. In his famous book, *Paris et le désert français*, Jean-François Gravier had mentioned the possibility on transferring to Toulouse " some of the directorship of French aviation (*délégation technique du Ministère de l'air, centres d'essais, École supérieure de l'aéronautique, etc.*) ". No other town was envisaged for this transfer, due perhaps to what Sfez (1976) calls an effect of the myth of " Toulouse, capital of aeronautics ". In fact, this myth was knowingly reactivated by the local prefecture services, which had their own project of industrial development based on aeronautics. In 1958, the local prefect became Minister of the Interior and his main colleague " secrétaire général " of the city. These two nominations helped bring the project to the attention of the government and city council. After the governement decision was taken, the local actors didnot remain passive. Academics particularly, played an important role in the operation, making the link between the national and local levels (Jalabert, Grossetti *et alii*, 1991, Grossetti, 1995).

The CENG's settlement enhanced Grenoble's scientific potential, without changing the basis of the local innovation system. During that period, several spin-offs were created by researchers, particularly in electronics and computers (Mors, Telemecanique and a lot of spin-offs from them), and the link between university and firms became stronger (Bernardy et Boisgontier, 1988).

On the contrary, the transfer of CNES to Toulouse was one of the three causes of a strong bifurcation, being the first industry to connect with the local resarch and higher education system. The CNES was altogether a research center and a space agency working with firms that came later to settle in Toulouse (Matra in 1979, Alcatel in 1982). At the beginning the space center of Toulouse was small.

It grew up hiring a lot of graduates from local higher education system and quickly connected with the local laboratories particularly in electronics, computing or astronomy. The second cause is the shifting, during the same period, of the old aircraft industry from a electromechanic technology to a digital one, especially with Airbus A320 program. The Aerospatiale company highly increased its R&D department and hired engineers in electronics and computing from local engineering schools. The third cause was that Motorola, which settled a factory in Toulouse in 1967, changed its strategy and decided to make some R&D in Toulouse. The three causes resulted in a big change for Toulouse. In a few years, a new local innovation system was born.

5. 1975-1999 : TWO URBAN INNOVATION SYSTEMS

After 1982, the left-wing government encouraged cooperation between firms and academic research and this kind of cooperation became more and more common.

During that period, Grenoble continued in the same way as before (Bernardy and Boisgontier, 1996). Some big firms (Merlin-Gerin for example) lost their freedom and became part of national or international groups. The system generated other innovative small firms but they didn not really grow up and they kept R&D as main activity.

In Toulouse, several spin-offs from laboratories were created from 1981, especially in software engineering or biotechnology. The number of research contracts between CNRS laboratories and firms fastly increased. The local market for engineers became very active. At the end of the eighties, Toulouse could stand the comparison with Grenoble as a urban system of innovation.

CONCLUSION

These parallel stories showed that the making of a innovation system can be very long and for a great part unpredictible. Among other conclusions, these two stories showed that :

1. Industrial and scientific paths are not necessary linked. Particularly, engineering sciences can develop without local industry helping. In Toulouse, the

lack of connection between the scientific system and local industry did not stop the development of laboratories and higher education courses in applied science. The same thing could be said about Stanford, which developed as a good engineering science university without any local industry until the middle of the century.

2. Engineering sciences are specifically important for regional development. There is a common point between Toulouse and Grenoble universities, Stanford (Silicon Valley) and MIT (Route 128) is that they have strong engineering sciences departments. Electrical engineering was particularly important because of the variety of specialities deriving from it (electronics, automatics, computing for a part, etc.).

3. Policies matter. If the urban innovation system of Grenoble could have develop without any specific policies, the Toulouse system is the result of complex processus where two kinds of political action were determining. The first kind of political action was local and not costly : it is the financing of the electrical institute by the town council. The hope of the mayor and his councellors was to help the region to get electrical powered industry. They did not succeed but they directed the faculty of science towards electrical engineering in a time when this direction was rare in the country. The second kind of political action, which was much more costly, was national : it is the transfer to Toulouse of a part of french spatial industry. The hope was to change Toulouse from a rural capital into a new high-tech industrial town and it was a success, because of the existence of the applied science organizations that could offer their graduates to the development of the local innovation system. Without them, no real local system would have develop : firms settles would have had far fewer connections (like in technological parks without universities and local labour market as Sophia-Antipolis). So, the two kinds of political actions, the local one and the national one, had many effects, even if these effects were for a large part unexpected in the first case.

4. Some old bifurcations can have long lasting effects. When Toulouse's Town Concil decided to help the faculty to create the electrical institute, they put money in very high technology and advanced applied science with the hope of a quick development of electrical powered industry in the Pyrénées. This development never happened but this decision changed for a long time the future of the local scientific system : it was a real bifurcation. After it, the scientific and academic logics resulted in the developement of applied sciences without any impulse from

local policies or industrial needs. When, sixty years later, another policy put a new high tech industry in the same area, the old applied science system revealed to be a good local partner for this industry.

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