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## The Midi-Pyrénées Higher Education and Regional Innovation Systems. .

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### *Summary :*

This article presents the regional innovation system of Midi Pyrénées, emphasising the part played by the academic world. It shows that public/industry research cooperations could be developed following two methods : the first one aims to the shared research between public and industrial laboratories ; the other one consists in (translation) transfer activities between the two worlds.

The triple helix model [Leydesdorf L. & Etzkowitz H.,1998 ] will be used as conceptual framework to analyze the interaction between three spheres, industry, research, governance. But if Leydesdorff has stressed the part played by communication, we show that path dependency and learning are very important for the creation of institutions and cooperation procedures for translation aims as well for integration ones.

On the other hand, we'll explain how institutional changes can modify organizations in the fields of cooperation between public research and industry.

The institutions act on processes either by enforcement, or by incentives and make co-operations possible through institutional arrangements.

The intersection between the three spheres is the realization locus of the institutional matrix proposed by North [North D. C., 1991]. Eventually we show that governance is a determining clue for cooperation between public research and industry. We illustrate our argument with French examples chosen within the Midi-Pyrénées Regional System of Innovation (with some references to Rhône-Alpes).

*Keywords: Institutions – co-ordination – knowledge – proximities – technology transfert – governance*

## 1. Introduction

Midi-Pyrénées is the largest Region in France (45,348 km<sup>2</sup>), but the density of population is low. The population increased to 2,465,200 residents in 1999 against 2,268,290 in 1975. It represents henceforth 4.36% of the national population, with a density of 56,27 inhab/ km<sup>2</sup> (108 inhab/ km<sup>2</sup> in France). Similarly 35 % of residents inhabit in a rural environment (23% in France). Moreover young people are relatively less numerous, and conversely, the old ones are more numerous than the French average (25.1% of the population has more than 60 years against 21.3% in France) notably in rural zones.

Date	Population*		yearly rate of growth		
	Mid-Py	France	Periods	Mid-Py	France
1975	2 268,29	52 591,60			
1982	2 325, 31	54 334,90	75/82	0,36	0,47
1990	2 430,66	56 615,20	82/90	0,55	0,51
1999	2 551,69	58 518,40	90/99	0,54	0,37

\*thousands

But the most striking phenomenon is what could be called a long term collapse of the rural world . If one looks at the census figures over a long historical period, one observes for example that the Department of Gers, in 1846, counted 314,000 hab., and today no more than 172,511, (that is a loss of 45%). Over the same period, Aveyron's population decreased by more than 100 000 inhabitants. At the same time, the regional capital enjoys a very quick growth and it ranks by now 5<sup>th</sup> if we are two consider the urban area as defined in the 1999 census.

		1999	1990	Δ 99/90	yearly growth rate
Paris	1	11 174 743	10 859 659	315 084	0,3
Lyon	2	1 648 216	1 551 133	97 083	0,7
Marseille - Aix-en-Provence	3	1 516 340	1 455 122	61 218	0,5
Lille	4	1 143 125	1 110 895	32 230	0,3
<b>Toulouse</b>	<b>5</b>	<b>964 797</b>	<b>841 152</b>	<b>123 645</b>	<b>1,5</b>

Till the last third of the XXth century, Midi Pyrénées was by and large a rural region with a low productivity and income agriculture. Changes have begun with the expansion of the higher education system in the sixties which could paradoxically be related to the backwardness of the region at this time. As the regional industry was not able to supply enough openings to match the labour supply released by agriculture, many young people went to the university to get a better job. For example, between 1962 and 1967 the number of students in the University of Toulouse increased from 14089 to 26340 (+87%), (whereas the baby boom effect could not be given credit for more than 20%). Therefore in 1965, the Midi Pyrénées represented students 6.2% of the French total (8.5% for the sciences) whereas the 15-24 year old class represented only 4.2%. By now, there are 100000 students in Midi

Pyrénées whereas the 20/24 year old class is composed of 157000 persons and the change of the training structure of the population is tremendous. The Table people were asked to indicate the highest level of the training system they have reached

Age	trainees	First level	Intermediate level	High school	Higher education	Total
15 19	140 389	919	10 607	1 792	256	153 963
20 24	76 406	2 238	33 313	22 320	22 847	157 124
25 29	13 040	3 751	55 265	30 495	67 603	170 154
30 39	2 057	12 058	163 197	72 043	116 261	365 616
40 59	0	125 758	260 100	130 299	148 671	664 828
Over 60	0	397 511	135 781	60 305	44 986	638 583
Total	231 892	542 235	658 263	317 254	400 624	2 150 268

<http://www.recensement.insee.fr/>

This huge investment in human capital is probably the clue to the good economic performances of the Region Midi-Pyrénées in the two last decades and is to be related to a sharp increase of the employment in the IT sector as well as in the RD sector. Between this investment and the corresponding supply of degrees, the networking of academic institutions with economic and local/regional ones should be stressed. Beginning in 1986 with an association (ADERMIP) this networking was reinforced in 1995 by the creation of the Pôle Universitaire Européen which is specially designed to favor cooperation.

Subsequently we will concentrate on the networking in the Regional innovation system in which the academic world plays an important part. We begin by a brief account of the theoretical framework of our research, then we will introduce the Regional Innovation System of Midi-Pyrénées which provides us with data and monographs and finally we present our findings and results.

### **1.1. Theoretical framework**

Our approach is inspired by two research programs, the neo-institutionalist one and the evolutionist one. They partake several characteristics and assumptions such as limited and procedural rationality<sup>1</sup>. Convergence and complementarities have been stressed by several authors [Williamson O. 1991]<sup>2</sup> [Foss N.J., 1994] [Brousseau E.,1996] [Hodgson G.M., 1996]. We applied these two approaches to the relationship between science and industry. Over the last thirty years, the sphere of science has abandoned an almost autonomous institutional field in which problems are defined and solved by the mainly academic interests of a specific community - *mode 1* - to enter another mode - *mode 2* - [Gibbons Mr. & alii, 1994] . This classification Mode 1, Mode 2 proposed by Gibbons and alii, is questionable especially from the historical point of view". Indeed the mode 1 and 2 are just highly simplified and limited analytical forms. A more detailed historical typology can distinguish all a range of mode of making and stating specific to each time and to each group " [Pestre D.1997], however it helps us to identify two distinct but nevertheless complementary tendencies, fundamental science (production of knowledge), applied science (production of techniques). Some authors have criticized the Mode 2"... hardly of theoretical utility because it masks behind its

<sup>1</sup> Choices are rational if the economic agents make (1) choices among a given set of alternatives, (2) to which are associated (subjectively) probabilities of returns, (3) such as the expected value of an objective function is maximised. If one of the three conditions does not hold, rationality is to be limited. This concept was introduced by H. A. Simon in 1947, he proposed later (1976) the concepts of substantial and procedural rationality as the future is necessarily imperfectly known. In the case of substantial rationality, the three conditions hold, and under supplementary conditions, the behaviour of such agents leads to a social optimum. With the procedural rationality, the social optimum is no longer warranted, but it implies that the agents behave to improve their situation till they attain a satisficing one.

<sup>2</sup> The point of departure of Williamson 1991 is the discrete structural analysis introduced by Simon 1978. He develops the part played by transaction cost to explain shifts of governance types.

reassuring simplicity, a proliferation of relations and of configurations the study of which can precisely define the socio-economic object of scientific research "[Callon in Callon Mr. & Foray D., 1997]. Nevertheless, the distinction is useful in our framework as in the mode 2, the production of knowledge takes place within a context in which problems are not set in a disciplinary but trans-disciplinary framework.

Inferring conclusions from the analyses of the Regional System of Innovation of two French regions Midi-Pyrénées and Rhône-Alpes [Brugarolas E., 1999] [Bes & Brugarolas 1997] [Alcouffe & Kephaliacos 1996], we shall demonstrate that the cooperation between public research and industry has been developed in the last 30 years within a two level pattern. At the microeconomic level, we find out an evolutionist process which can be described as the following chain "goal -constraint - selection - feedback" (see infra 3-1). It helps to understand the coordination between actors. At the upper level, we use North's theory of institutional change, to present the action of institutions, their dynamics and the "triple helix" devised by Etzkowitz and Leydesdorff [Etzkowitz H., Leydesdorff L. 1997, 2000] which allows us to describe the functional features of co-operation. We want to show that this model allows to take into account the integration, translation, and institution process. We will show how the studies of D. C. North about institutional change theory [North D.C., 1991] can support our analysis.

The methodology chosen by the initiators of the "triple helix" model is the one of differentiation, integration and translation between the different systems (the academic, industrial and governance ones) by means of communication. The triple helix model takes the traditional forms of institutional differentiation among universities, industries and government as its starting point. ([Etzkowitz H., Leydesdorff. L. 1997, p. 107). But integration requires a common language whereas translation requires the creation of an interface, the differentiation being for each protagonist connected with their relationships with the "helix" they belong to

The "triple helix" is the pattern representing interaction between functional and institutional ferments in society. Drawing initiatives of the Regional System of Innovation of Midi-Pyrénées and Rhône-Alpes, we shall define the differences between translation and integration systems.

### ***1.2. Improving the "triple helix" model***

We argue that the triple helix model can be used to explain the development of public research industry cooperation. These collaborations are supported by institutions à la North aiming to : either integration in the context of shared research (see infra 2.2 for examples and 3.2 for a discussion) or translation with the illustration by the technology transfer centers (see infra 2.3 and discussion infra in 3.2.).

Starting out with the triple helix model, we analyze the dynamics of each helix (sphere) and show how interactions between the three spheres occur. We enlarge the initial model emphasizing that the "i space" , which represents the intersection between the spheres (see fig. 2) - the communication and/or translation locus in Leydesdorff's terminology - , comes in a variety of organizational forms, which correspond to constraints pertaining to institutions or performed functions which are not confined to communication. The configuration of this "i-space" is an evolutionist process in which we find learning and path dependencies (see. 3.1). This process modifies the institutional matrix which is the core of the triple helix.

The improving of the "triple helix" model through the contribution of the studies developed on learning, confidence, through the studies on proximity's and on the asymmetry of information must enable us to analyze at best the structuring effects [Mansfield E & Lee J.Y. 1996] and the dynamic of infra-institutions set up by governance [Garrouste & Kirat

1995] whose role is to act as initiators, mediators and disseminators of information [Colletis, Perrin 1995] [Bellet 1995].

The institutional and organizational forms change in the process of time; they result from learning, accumulation of skills, they are linked to more or less coherent and appropriate conjectures. We illustrate our argument by an example of cooperation in the transport electronics sector of Midi Pyrénées.

## **2. Integration and translation systems on R.I.S. (Regional Innovation System)**

### ***2.1. Midi-Pyrénées Regional Innovation System and Transport electronics.***

In order to illustrate the part played by governances<sup>3</sup> in the development of cooperations between public research and industry, we scrutinize cooperations which occurred in the transport electronics systems in the Midi-Pyrénées region.

a) It is important to note that during the 60' the CII<sup>4</sup> which produced computers and Thomson CSF which produces electronics materials for the defense sector were both established in Toulouse. In the Midi-Pyrénées region, among fifteen large companies producing electronic or electric components for cars, there are two important parts manufacturers: Motorola semiconductors and Siemens automotive which are connected with the research sector and have both 5000 jobs, Rockwell Collins, and some SMEs as ACTIA which produces electronics systems embarked on trucks or tractors. There are also customers belonging to various transport sectors: Aerospatiale, Dassault, Latécoère, Socata (aeronautics), Matra Marconi Space, Alcatel Espace, (space industry), GIAT (tanks), and Alstom (trains).

The research laboratories involved in electronics have maintained cooperations with these companies and some of them have also agreements with PSA and Renault (car manufacturers) or in the case of ACTIA, with trucks and tractors manufacturers.

b) Targeted research is subsidized in France through fundings included in government or EU programmes<sup>5</sup>, it benefits also from fundings by Regional Councils which invite bids.

We track in [Brugarolas E.,1999] the stories of parts manufacturers and the part played by academic research in the 60's and the 70's in the establishments of Motorola and Renix (a joint venture between Renault and Bendix eventually bought by Siemens Automotive). Several researchers were first in charge of laboratories, then chaired research centers in large manufactures then CEO or executives in their companies [Grossetti M., 1995]. These careers are certainly important for the development of cooperations in this region.

c) Regional governance, (which core is the Regional Council) has continuously encouraged cooperations between public research and industry despite changing political majorities. The Regional Council has followed government policies concerning targeted research and transfer. It has also set up its own policies which contributed to the creation of 10 laboratories combining public researchers and industry between 1990-1998 and favours the creation of 5 technological research networks around 2000<sup>6</sup>.

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<sup>3</sup> Governance includes politicians (representatives, senators, members of the regional and department councils), expert committees, chambers of commerce, and other influential men in informal (and sometimes secret) networks.

<sup>4</sup> At the beginning of the 60's, as General de Gaulle was aiming to develop the French independence vis-à-vis the United States, the French government decided to produce its own nuclear weapons. But the USA retaliated and refused any exportation of high tech materials which could be used in relation with H bomb matters. Following this embargo, the Plan Calcul" was launched. It included the creation of the IRIA (now INRIA), a specialised public establishment for research in computer science and automatics, of a great computer manufacture, CII (Compagnie Internationale d'Informatique) with private funding but subsidised by the government and linked to Thomson and CGE (Compagnie Générale d'Électricité).

<sup>5</sup> for example diffusion programmes such as le PREDIT or JESSICA, PROMETHEUS.

<sup>6</sup>We included in our research interviews with actors (politicians, heads of laboratories, managers) but first we analyzed the available data which are very useful to uncover and measure cooperation. Using the database INSPEC which include 5000

We will show now two kinds of institutions (common laboratories and regional centers for innovation and technology transfer). The first ones are devoted to shared research with long term objectives (2-2), the second ones are institutions which give technological support to short term cooperation and are mostly turned towards SMEs (2-3).

## ***2.2. Integration systems : the common laboratories and the transport electronics sector of Midi-Pyrénées;***

### The common laboratories in Midi-Pyrénées

Originally at the end of the 80's, the CNRS has created the Mixed Research Unit which were intended to permit cooperation between scientists and industrialists in a common laboratory. We found in the provisional budget of the Regional council for 1986 the following statement under the title : “ incentive to create mixed R&D laboratories ” : the objective of this action is to create research centers of interest to firms in the promising sectors. The financial involvement of firms in these programs prove the economic interest of these investments. The regional funding will be on sliding scale and provided for several years (4 to 5 years), while the funding will be taken over progressively by the industrialists. Such devices are currently developing in the USA and improve the relationship between industry and research. The concerned fields could be, for example, superconductors, telecommunications, artificial intelligence, spatial medicine, nuclear technology, etc.

Such several laboratories were created in 1988 and in the following years (cf below)).

THEMATIC	NAME LAB.		Public lab.	Industry firms
Acoustic research action	AREA	1990-94	ONERA-UPS	Technofan
Human Computer Interface	ARAMIHS	1988-95	IRIT-UPS-CNRS	Matra Marconi Space
Multimedia communication	URACOM	1989-97	IRIT-UPS-INPT	Opus Alcatel
Optical Disc- mass memory	ODIL	1989-94	UPS-CNRS	ATG Gigadisc
Automotive System	MIRGAS	1990-95	INPT-IMFT-CNRS- LEEI -	Siemens Automotive
Captors Integration	LCIP	1994-98	CNRS - LAAS <sup>7</sup>	Motorola Semicond.
Dependability Engineering	LIS - LIS II	1992-	CNRS - LAAS	Technicatome, Aerospatiale, Matra, EDF
structural materials aeronautics	AMSA		UPS-CNRS-INPT	Aerospatiale
Economic Energy Environment	LEESP		CNRS - CEA	Nuclear Agency CEA

We studied the links between two laboratories: IMFT and LEEI<sup>8</sup> and the Siemens Automotive Company in Toulouse. The first cooperations (1982-9) were organized by limited contracts. Then in 1990, the partnership was shaped up well and a common laboratory was created, the MIRGAS<sup>9</sup>. Eventually at the end of this experiment, the head of the two

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items devoted to scientific publications in electronics or computer science, we could find out actual or potential cooperations and prepare our interviews [Bes M.P. & Brugarolas E., 1997] [Brugarolas E. Dkaki T., 1997].

The PROTOCOLE database which include the 6700 contracts of the CNRS engineering sector which allow us to identify formalized cooperation concerning our topic, to identify contracting parties, the importance and lengths of these contracts. The INPI database, we could uncover patents concerning entities related to Midi-Pyrénées.

<sup>7</sup> LAAS Laboratoire d'Analyse et d'Architecture des Signaux –Toulouse – CNRS

<sup>8</sup> IMFT Institut de Mécanique des Fluides de Toulouse - CNRS

LEEI Laboratoire d'Electrotechnique et d'Electronique Industrielle – Toulouse – INPT-CNRS

<sup>9</sup> MIRGAS Mixt Research Group Automotive System – Siemens Automotive, LEEI-CNRS-INPT, IMFT-CNRS-INPT, LAAS-CNRS. Created on March 9 1990, when the contract came to an end in 1995, the cooperation evolved into a higher stage with the IERSET creation.

laboratories decided to open their relationship to other partners through an institute, the IERSET<sup>10</sup> (1996), which provided the framework for a network of technological cooperations in the field of transport electronics, including other industrialists and research teams.

If we scrutinize the different steps, we notice that the institutions supporting these cooperations evolve as time goes. Until 1990, the procedures for funding research were organized on a disciplinary basis and material only was funded in the framework of industry research cooperation. Taking into account the funding procedures of common laboratories enacted by the Regional Council, the actors were encouraged to sign four years long contracts, emphasizing their long range, targeted, and federative character as recommended by the Regional Council.

The CNRS<sup>11</sup>, for its part, set up contract forms in order that the distribution of the royalties includes research laboratories. Consequently the two laboratories involved in the cooperation receive their part of the royalties from the resulting patents taken out by the industrialist. As simultaneously the disclosure of results is important to the researchers, the problem has been solved in the prior contract, by an agreement along which the researchers accepted the one year secrecy lag demanded by the industrialist.

The relationship between researchers and Siemens engineers during the first contracts have been a good experiment creating trust between them. The mutual learning of working habits their ability to define together the “ output ”, have played a major part in the partnership’s development through a common institution. The new contract was more detailed; it mentioned the funding commitment of all partners, as well as the human resources and the material involved.

Uncertainty about the progress and the outcome of the cooperation has been reduced in the course of time, the whole institutional device has changed the mental models of the actors in order that they could commit themselves in a demanding cooperation such as a common laboratory.

After four years, the resulting outcome of 9 patents was positive and leads to a new organization. Partners were satisfied with their cooperation, they wish to continue it, but the means at their disposal were too restricted. Their ability to work together make them confident and ready to organize a network open to other partners and devoted to the transport electronics. It is worth to notice that the involved industrialists were not directly in competition, as the technologies were not a specific market. Consequently they could organize a network including transversal and generic implementation, in the framework of a federative institute, the IERSET. Around each targeted topic, the concerned parties meet together and define their agenda (with a 18 months to 3 years horizon), if inspections are regular, every small team is autonomous and presents its progress and outcomes to a scientific council. Synergy is very important between the involved persons who originally belong to laboratories or high technology firms in the field of transport electronics.

If we were to review all cooperations experiments which have resulted in common laboratories, we will check that at the end of the experiment, either the organizations disappear or they are evolving into a more complex network of which they are the core. A

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<sup>10</sup> Institut Européen sur les Systèmes Electroniques de Transports (European Research Institute on Electronic Systems of Transportation) - the first network of research created in Midi-Pyrénées was set up by managers who had undergone the experience of common laboratories. These managers are interested by the same technologies applied to different sectors, therefore they are not competing one against another which facilitates their cooperation on specific topics. "IERSET", European Research Institute on Electronic Systems of Transportation, ; industrial creativity partnership : Aérospatiale, Actia, GEC Alsthom, Gerac, Giat Industries, Siemens, Sintors, SNCF since 98, Thomson-CSF, Motorola - scientific partnership LAAS-CNRS, IRIT-CNRS-UPS, CERT-ONERA, ENSICA, CNES

<sup>11</sup> National Center for Scientific Research (CNRS), Center for Atomic Energy (CEA), ONERA, DRET, INRA, INSERM, CNES... altogether over 100 000 researchers are working for these agencies in France.

variant of the latter is the mutation in another organizational form as for the LCIP which has become a technological platform.

### ***2.3. Translation systems : the CRITT and technological agencies in Midi-Pyrénées and the Rhone Alpes region;***

CRITTs stand for regional innovation and technology transfer centres. They were created in 1982 by the Ministry of Education, Research and Technology. Then the Government and the Regional Councils have included the CRITTs in the plan contracts between the government and the regions. Their mission is to help to technology transfers to SMEs. The first one was created in Midi Pyrénées in 1987, there are 8 now in Midi-Pyrénées and 120 in France.

*“ ... CRITT are given numerous and various missions : training to new technologies, implementation of the output of public research laboratories, realisation of technological services.*

CRITTs have been created to provide with R&D advises SMEs of which the functional structures, the scientific, technological and financial capabilities are too limited to develop their own R&D services. “ *A small firm with less than 20 employees cannot afford to hire a full time R&D engineers* ” as we were told by Mr. Carrier, Director of Midi-Pyrénées inter-CRITT. There are different categories of CRITT, some are specialized, others are concerned by the whole sectors or by a range of technologies. These structures do not have a specific statute. Some CRITTs are independant legal entities or simply department in an university or an engineering school. They have also different kinds of relationship to their environnement, they can be dependant upon professional bodies (esp. Chambers of Commerce - CCI), or one or several academic laboratories. They have also different labels : some are technical CRITTs, or CRITTs with platforms. Others are interface CRITTs as in Rhône-Alpes. The latter just directs their clients towards experts.

French government has determined special features the CRITTs should exhibit to be supported in the 2000-2006 plan contract. Such a CRITT should fit firms wants. When it is created, evidence of firms wants vis-à-vis the CRITT should be supplied, previous cooperation experiments should be supplied by the entity which supports the project or is supposed to provide logistics. The CRITT should be supported by one or several research teams and benefit from resources and laboratories' skills. It should network with other technology transfer structures in order to satisfy SMEs wants directing them towards the best sources and avoids to duplicate public fundings. The CRITT should not become a competitor vis-à-vis the private sector (esp. consultancies), but provides complementary services, such as canvassing, awareness campaign, first help, ....

a) In Midi-Pyénées, the government and the Regional Council have specified CRITTs missions from their creation, they have to provide SMEs with information about technologies, but also to realize if necessary technologies transfers.

Specialized CRITT(s) - They have been provided with large facilities and are able to supply firms with services. They are linked to research laboratories, sometimes laboratory facilities are located at the same place than the CRITT. This enlarges the facilities available to the two entities, their clients are scattered all over the country. They master diffusing technologies which can be directed to various industrial sectors and are continuously refreshed by the output of the research laboratory. The CRITT and the laboratory partake the same location and the work is allocated to the laboratory or the CRITT along its nature. If the service concerns a technology mastered by the pair CRITT-Laboratory, or a formation to a determined technology, or a technology transfer from one sector to another one, it will be directed to the CRITT. It is worthwhile to note that the uncertainty about time limit and

output is small. When the service or mission concerns a technology at an initial stage, with a remote time limit or with an uncertain limit, it will be directed to the research laboratory.

Generic CRITT(s) - Generic CRITT(s) are orientated towards determined sectors and interface firms with regional public research. They are mostly located in industrial district and work with regional firms. They have less facilities than specialized CRITTs. They are often in touch with very small firms which they help to express their wants. If we except the environment CRITT which is located in Toulouse and is not devoted to a sector, the other ones can be called sectorial or generic. Limited budgets and lack of availability of staff make the otherwise necessary scientific and technological refreshment difficult for these CRITT(s). How the CRITT(s) are run: in 1996 the 8 CRITT(s) have a staff of 54 permanent employees, including 19 engineers, 16 technicians, 4 researchers et 15 secretaries. For CRITT(s) linked to laboratories, it is difficult to assess the part played by researchers belonging to the laboratories in the CRITT activities 1. In Midi-Pyrénées, CRITT(s) have almost all to their disposal technological platforms the value of which amount up to 100MF. Moreover the services they charge, the CRITT(s) are involved in missions benefiting to the social welfare : diagnoses, free teaching, technical exhibitions, technological watch, etc. CRITTs perform collective services directed to SMEs (technology accounts, demonstration, documentation). It is difficult to charge the cost of these social welfare services. These activities which form 40% of the activities of the CRITT are subsidised by the government, the Regional Council or other bodies (Chamber of Commerce).

#### Midi-Pyrénées CRITTs features

CRITT Sector	Creation time	Implement time	Location	specialized - generalist sectoral
Agro processing CATAR Toulouse	1991	1992	HES Toulouse	specialized
Bio-Industries Toulouse	1990	1986	HES Toulouse	specialized
Food industry - Auch	1988	1988	CCI Auch	sectoral
Wood - Rodez	1991	1991	CCI Rodez	sectoral
Glues - Tarbes	1990	1990	E.N.I. Tarbes	specialized
Automatics - Albi	1989	1989	City Albi	specialized
Environment -Toulouse	1992	1993	HES Toulouse	generalist
Industrial mechanics Toulouse	1987	1988	HES Toulouse	specialized

CRITTs are yearly audited by the Regional Council and DRRT. Objectives are consequently determined in order to maintain the balance between collective actions, free advises, training and transfer which are not free. Moreover the supporters stress the importance of links to scientific laboratories so that scientific and technological refreshment be completed. The Rhône-Alpes governance has chosen other options.

b) In Rhône-Alpes the abolition of CRITT or their transformation into technological agencies provides us a supplementary example of institutional and organizational dynamics. The missions devoted to each organizations have been clarified while organizations were fitted to the technological demand they receive. Moreover it was necessary to clarify the relationships between those who order some services and those who provide them inside the nebulous technological consultancies. The different aspects involved in the technological transfer have progressively become apparent and make necessary some organizational and functional adjustments which have been implemented after an experimental period of ten years. There were 5 CRITT in Rhône- Alpes since 1988 and only three survived. Two of them

have a large scope and their skills was mostly geographical (Drôme Ardèche and Savoie). They are linked to their Chambers of Commerce. The CRITT devoted to agricultural resources, is hold up too while those devoted to surface treatment and polymers are suppressed. The reasons why these decisions have been taken are interesting to analyze. The CRITT are jointly organized by Regional Council and/or State, and /or Universities, and/or Chambers of Commerce, and/or other professional organizations. The first reason to suppress some CRITTs is clearly linked to their failure to develop their activities, but the necessity to clarify their mission and especially to disentangle their activities consisting to spread technologies from those consisting to provide R&D services plays an important part too. As in Midi-Pyrénées, the CRITT mission included technological consultancies, consequently it could happen that they define for PTR and they perform consultancy. Even if the Regional council did not fear that the CRITT in these cases ordered task that they will perform themselves, it judges that the risks that they become involved in cross ordering were real. Consequently the Regional council has wished to split their functions so that the technological diffusion network (French acronym RDT) which is the ordering unit be separated from the providers which could be laboratories or technological agencies. The latter become super CRITT the mission of which is no longer to be in touch with the whole industry but only with the high tech firms. For example, the ARATEM (guidance and better material expertise) has been substituted to the CRITT “material”. It will provide firms with a technological support and expertise, it will federate and coordinate actors, it will take advantage of the laboratories R&D devoted to the elaboration and transformation and implementation of materials. This activity is targeted at firms for which materials play a strategic part. The RDT counselors decide to orientate firms towards the agency which perform the consultancy. It is worth to mention that contrarily to the Midi-Pyrénées case, in the new Rhône-Alpes set up, neither the technological agencies, nor the CRITT perform themselves the transfer which is incumbent to university laboratories, or national technological centers or private consultancies.

The Rhône- Alpes case shows than analyze of the ordering and performing of R&D has lead to a structural evolution, some structures have been suppressed, other such as ARATEM have been created, some CRITTs have been preserved while the missions of other have evolved.

### **3. Analysis of the cooperation system**

The triple helix model is very convenient to analyze the dynamics of cooperation providing us with useful tools as the integration system (3-2), translation system (3-3). The distinction between the integration and cooperation occurs in the intersection between spheres, but we argue that the choice between the kinds of cooperation follows an evolutionist process which leads to institutional arrangements (3-1). These arrangements form the institutional matrix in North's terminology.

#### ***3.1. Process “goal -constraint - selection – feedback” on low level.***

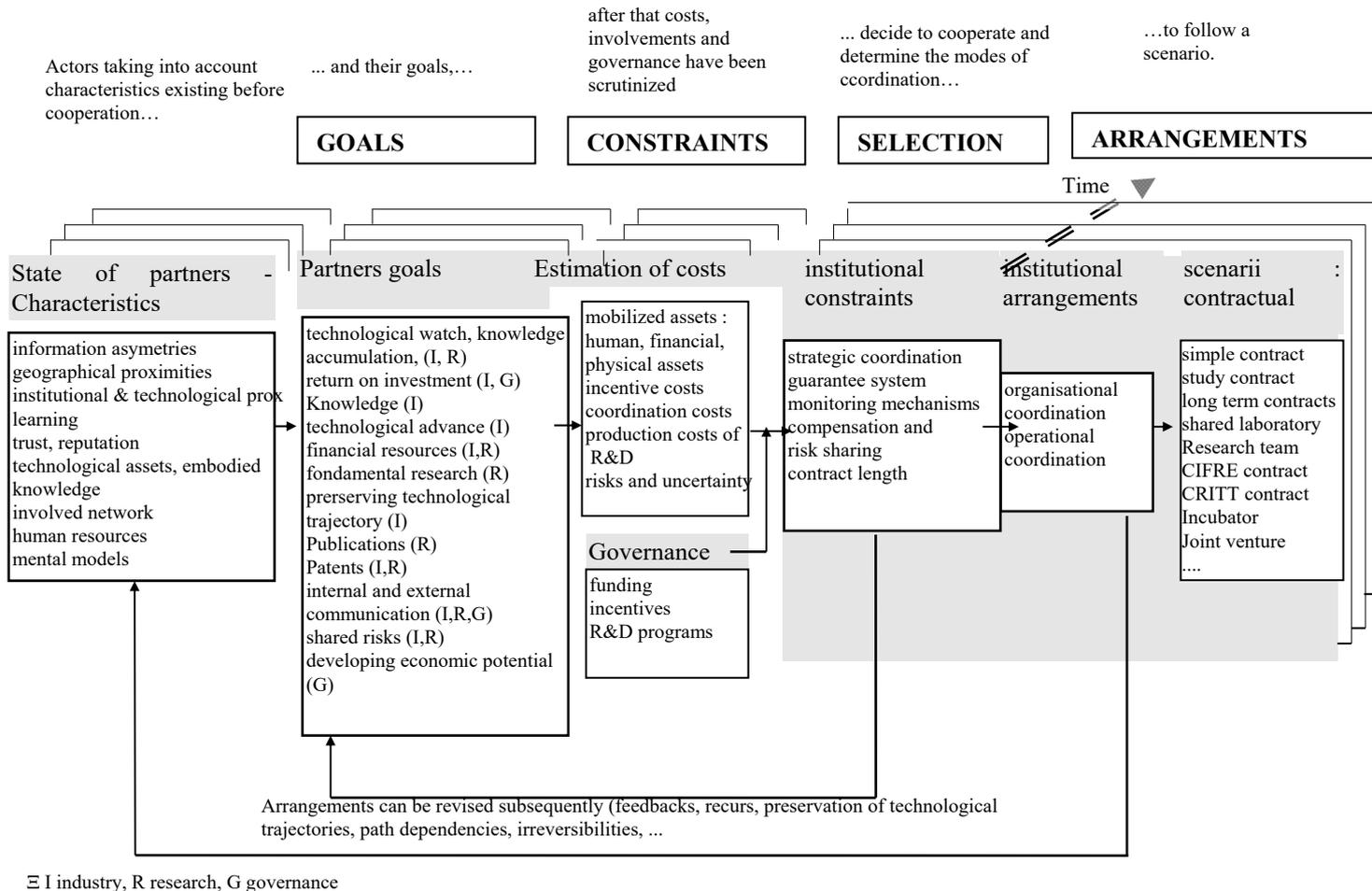
We find an evolutionist process which can be described as the following chain “ goal - constraint - selection - feedback ” (fig 1).

Some features have to be found before any cooperation, they define the partner “ states<sup>12</sup> ”. Partners decide to cooperate taking into account their goals, the constraints and the expected co-operation costs and the *governance* implication. The cooperation framework is determined by the formal institutional arrangements, which along contractual devises, define the content of depictable scenarii. Arrangements can be later revised to take into account actors or

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<sup>12</sup> we mean the idiosyncrasy of each actor : economic or technological resources, comparative advantages, trust in every possible partner, accuracy of the information on partners, mental models of organisations / decision-makers

institutions evolution or fade away, they build a base for the system dynamics. They allow to deal the special features of innovative process (feedbacks and recurrence exhibited by scientific and technological trajectories dynamics, but also irreversibility, path dependency, new mental models, ...). These formal institutional arrangements are the founding blocks of the economic system of cooperation between public research and industry.



**fig 1 : The microeconomic process « Goals - Constraints - Selection - Arrangements - Feedbacks »**

Our investigation of the regional innovation system of MIDI-Pyrenees especially the transport electronic sector suggest some conclusions: the individuals and territories' history as well as technologies' history matters if we have to explain the development of cooperation between public research and industrial firms.

Therefore the evolutionist approach which is non-deterministic, is relevant, especially through its emphasis on increasing adoption returns or learning phenomena. Cooperation between science and industry is not natural, it is socio-technical and requires many compromises reached through incentive mechanisms which are specific to each spheres. The different possible kinds of coordination combine technical devices, rules, trust, resources which are "mobilized" by actors in order to cooperate in their research activities. All resources are of course not systematically mobilized.

Five postulates underlie our assumption of logic's of relations

1) rationality : when several modes of coordination are available, actors have to arbitrate. For instance, if trust is strong enough, partners will choose this mode of coordination instead of formal complete contractual device.

2) procedural rationality : agreements require to be analyzed as procedures of their own kind. These procedures can be stored, reproduced or cancelled.

3) links between technology and coordination strategy: consequently, the agents will not have the same requirements vis-à-vis the rules or trust if they have chosen fundamental or applied research. A team of researchers or a businessman will not deal about strategic topic if it had no previous relations with a partner. Trust will be essential to cooperation on critical issue. It is based on collective experience. Therefore, cooperations are techno-organizational forms which underlie the existence of a relational logic's.

4) link between learning, trust and coordination. A long term cooperation lasting several years such as a partaken laboratory requires experience and trust accumulated by actors.

5) proximity effect in the development of cooperations. From our investigation in the data banks, we conclude that proximity plays an important part in the cooperation between researchers and industrialists. Geographical concentration facilitates the propagation of non stabilized and tacit information. Success in cooperations depend heavily on tacit knowledge. Trust is based on elements which are very specific as “ home made ” know-hows which are not transferable and remain tacit. Geographical proximity facilitates local learning based on tacit knowledges, frequent contacts and it reduces the possibility of opportunistic behaviors.

We will check if the introduction of cooperative work using new information and communication techniques will modify this evaluation of proximity.

Last but not least, let us remind that coproduction which can appear in applied targeted research create interdependencies between contractual partners.

Our investigation on contracts involving engineering sciences has proved, on the one hand, that industrialists are more likely disposed to call laboratories close to their research centers (90% of the cases in Midi-Pyrénées) and this proximity facilitates business relations. On the other hand, 40% of the contracts between Midi Pyrénées laboratories contract with regional industrialists (the same holds in Grenoble). At the beginning of our investigation, we expected that cooperation involves networking. Actually, we discover that there are bridges between laboratories on the one hand and between laboratories and industrialists which form networks. But if many scholars stress the importance of any nodes in networks, we have discover that a few number of laboratories “ catalyze ” a great number of contracts. Consequently, we choose to see these special nodes as “ lumps ” and characterize this networking as “ lumping ” process. We cannot omit that the incentive policies developed by the Government and the Regional Council are designed to preserve or to increase this proximity effect. Policies supporting local endogenous development or local productive systems or scientific parks concur to the same results. This microeconomic model clearly acknowledges and takes into account the importance of institutions which supply constraints and incentives and lead to institutional arrangements. The microeconomic process “ Goals - Constraints -Selection - Arrangements - Feedbacks ” takes place in an institutional framework which supplies constraints and incentives during the whole processes (fig.4). The final arrangement depends on the state of the institutional matrix at the time of its start up.

### ***3.2. Research activities shared within the integration systems :***

According to the pattern of "triple helix" (fig 2 & 3), the intersection of the different spheres (helixes) - industry, government and public research - defines a common language. The intersection is the "place" of integration, for instance a natural language, possibly a common language between researchers working in the same field in which implicit knowledge is introduced by each protagonist - be they industrialists or academics - and the

specialized jargons can be translated into a common language. Each sphere is able to perform reintegration through differentiation in itself starting from the *episteme*<sup>13</sup>.

We want to develop this pattern showing that the "i" space on the drawing, place of communication or translation in the sense of Leydesdorff can be expressed by a multitude of functional means corresponding to functional needs and takes into account institutions beyond the communication problem.

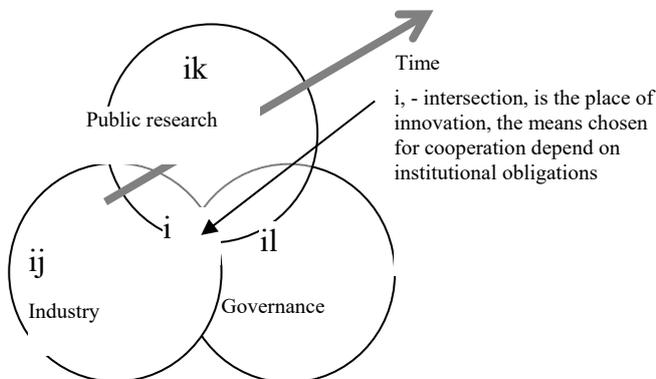


Fig 2. Triple helix - Case of an integration system

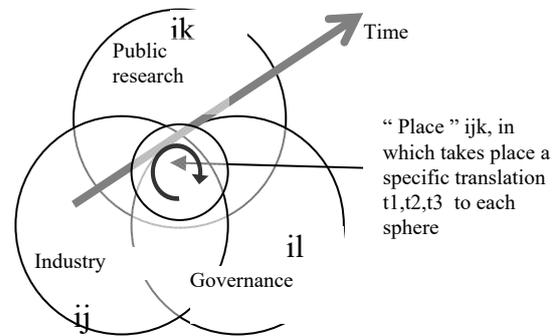


Fig. 3. Case of traduction system

To meet this need for integration, hybrid institutional forms [Cassier M., 1995, 1997], common (see 2.2) or mixed laboratories, network of technological research have been set up in Midi-Pyrénées and Rhône-Alpes. We are in a context of shared research<sup>14</sup> and such common laboratories have a complementary role to the R&D performed within the firms. We shall show that beyond the specific problems of communication (and to ensure coordination) and optimised system of integration needs to take into account other characteristics : mutual information of the protagonists, insertion in time, closeness, gathering resources, mutual trust, co-definition of schemes, suppression of information gaps...

Integration is in fact *endogeneisation* through the institutional matrix organization as put forward by North in his theory of institutional change. [North D.C., 1991]. Our work's core is the emergence of institutions and the functional means they entail as well as their nature, their durability, and their "interest".

*"Institutions are the humanly devised constraints imposed on human interaction . They consist of formal rules, non formal constraints (norms of behavior, conventions, and self-imposed codes of conduct (and their enforcement characteristics.)"* [North D.C., 1991]. We show how the institutional change becomes endogenous and in this way we follow the works of North D.C.

With this approach, institutions can be considered as the game rules and organizations as the players, the interaction between the two being the key to institutional change.

<sup>13</sup> We use here the concept introduced by M. Foucault in "By episteme, we mean... the total set of relations that unite, at a given period, the discursive practices that give rise to epistemological figures, sciences, and possibly formalized systems; the way in which, in each of these discursive formations, the transitions to epistemologization, scientificity, and formalization are situated and operate; the distribution of these thresholds, which may coincide, be subordinated to one another, or be separated by shifts in time; the lateral relations that may exist between epistemological figures or sciences in so far as they belong to neighbouring, but distinct, discursive practices. The episteme is not a form of knowledge (connaissance) or type of rationality which, crossing the boundaries of the most varied sciences, manifests the sovereign unity of a subject, a spirit, or a period; it is the totality of relations that can be discovered, for a given period, between the sciences when one analyses them at the level of discursive regularities (Archaeology p. 191).

<sup>14</sup> The difficulties on the "science market" can no longer be summed up in terms of incentives or prices, it is now the definition and the common identification by contractors of the objects to build and the works to carry through , on the use and association of new resources, on their production, and finally on the share of the benefits of the contracts". [ Cassier, M.95]. Following these arguments Cassier and other authors [Gonnard T, 1992] , [Mowery 1994] put forward the idea of shared research.

On the other hand, the differentiation process is a process of interaction between the "place" of the finalized shared research and the sphere each protagonist belongs to. The academic research worker has to legitimize his/her work through permanent immersion into basic data possibly imagine new methodology. The industrial engineer must report to his company on the work done and how it relates to its projects. Finally, governance through experts must be informed about the economic effects or technological breakthroughs (patents, publications...) it has generated through its technological policies and inducements. These economic effects will legitimate the politicians' choice towards people.

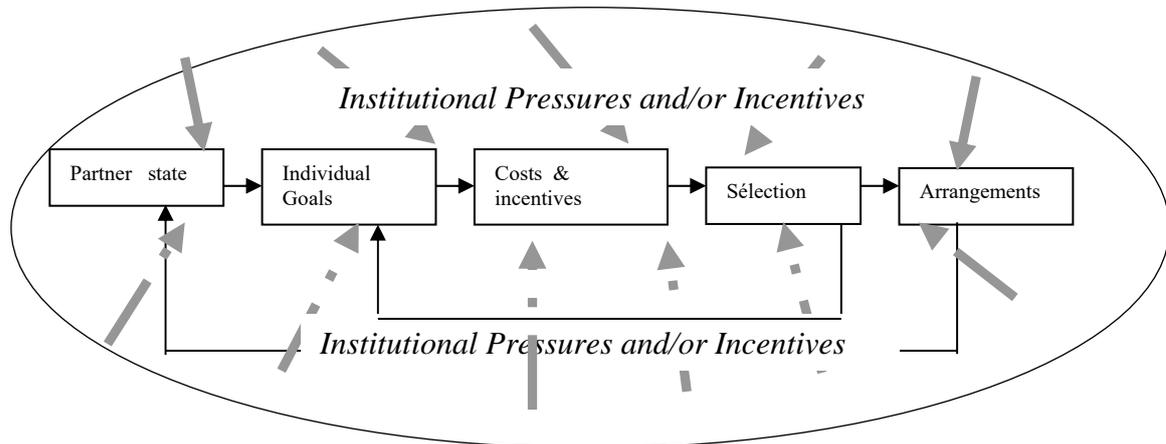


Fig. 4 Institutional pressures and evolutionist process

### **Public Research : interaction of scientific and technological production means**

It is within the interface of the various patterns in the sense of Gibbons, Mode 1 disciplinary research developed in the academic world, and Mode 2 finalized research based on networking together with other teams or industrialists, implying interface that the "helix" of public research is a benefit to the whole system.

The interconnection of both patterns is known and can be proved at any time. In Midi-Pyrénées, most finalized technological realizations are realized by the most advanced laboratories in the scientific field (LAAS, IRIT)<sup>15</sup>. Researchers are looking for credits to finance their works, to finance doctorate or post-doctorate scholarships. They turn to the governance for finances and come to agreement with it on shared research in the technological field or transfer close to their academic specialty.

The characteristics of the contracts will vary according to whether they deal with research or basic transfer. There is a huge variety of possible institutional agreements. The amount of time needed for the rapid transfer of technology asked by a SMEs will be very different to the time needed to set up a shared research cooperation with a large firm on scientific issues. The same applies for the resources involved : both human and financial...

The process of differentiation is linked to the fact that the researcher's gratification is linked to the recognition by his colleagues, through publications, thesis, and in return the basic discipline or at least the work within a frame codified by science is a necessary path. To be granted recognition sometimes means to follow a very intricate path indeed, some topics of applied targets research that can be far from the needs of basic science. The authorities (MENRT, Technology Management...) are trying to set up an evaluation process enabling to

<sup>15</sup> LAAS : Laboratoire d'Architecture et d'Analyse des Systèmes, CNRS Toulouse, IRIT : Institut de Recherche en Informatique de Toulouse, Ecole Normale Supérieure d'Ingénieurs en Mathématiques Appliquées de Grenoble

take into account co-operative (Mode 2) finalized research in order to favor those who decide to dedicate themselves to it.

As we will show it further on, researchers are faced with translation or integration processes which will depend on the framework of their co-operative research, long program scheduled upstream or short technology transfer with a SMEs etc.

In a similar way, various methodologies, functional organization and co-ordination will be the elements that define the cooperation pattern, the codes involved, the necessary informations' and degree of confidence.

### ***3.3. Systems of translation for technology transfer :***

In the "systems of translation", differentiation is such that there is no common language. The common zone of the spheres interpretation has disappeared. The "system of translation" is described as a hyper-cycle which can be generated by a series of selections which the different systems of communication use together. We shall come across this type of situation in the Center of Transfer of Technology associated with research laboratories.

This is an emerging system : at a given time we can only notice the spreading of communication. Translation generates representations which are specific to the situation. The system of translation must be considered as a network which exists and reproduces itself in an arrangement in which underlying communicative structures have to survive in their specific niches. The "place" of translation between spheres (interface or institutions) exists in relation to clearly-defined methodology and exchanges between a researcher or with an engineer in a transfer center, and an industrialist. This approach enables us to tackle the methodology of cooperation problem.

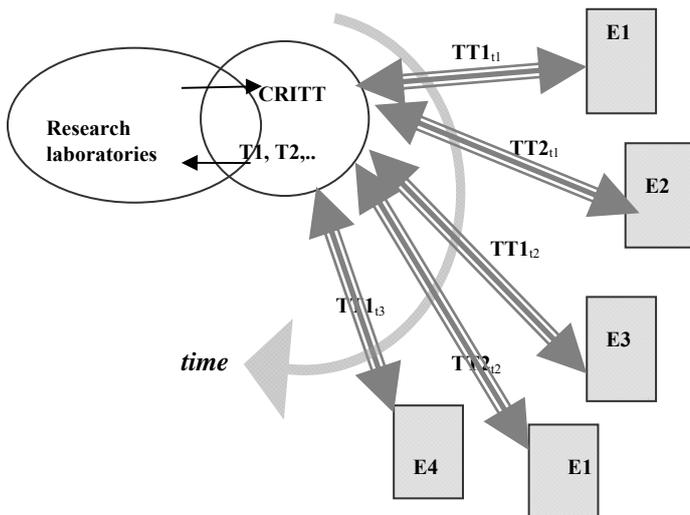
The "common language" (*episteme*) referring rather to a system of common representations of real or symbolic objects, must not lead us to believe there are single solutions of translation processes or interface institutions. What will be valid for a given field or university will not be recommended for another field. A "translation" is specific to a network of cooperation in *mode 2* (cooperative finalized research) but the features have to be functionally legitimized in *mode 1* - basic disciplinary or fundamental research for the researcher, introduction into the industrial process for the industrialist. The technological centers, transfer agencies<sup>16</sup>, technological methodologies, are the main components of translation systems. Their common characteristic is the need to give a quick answer to any technological problem put forward by an industrialist. The methodology is the use of a specific technological know-how in a specific field. This ability results from earlier experiences or from already known technologies with the idea they may be applied to a specific field. The request of the industrialist is a targeted one, the time constraint is strong, the resources available and the time of the industrialist are weak. Therefore, the engineer or the engineers-researchers will have to operate in double translation. Firstly, translate the industrial problem into a science -technology methodology and find an answer if there is one already. If not, turn the methodology into a subject of research if it is worth it. If there is a ready solution, it has to be translated, that is to say transfer the technology to industry , together with the methodology needed for implementation.

If there is no immediate solution and if the issue is an interesting one, the engineers-researchers of the technical centers can within a differentiation process call upon the scientific sphere to which they belong to launch a program of research.

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<sup>16</sup> There are about 30 agencies of transfer in Midi-Pyrénées. They are often close to the industrial world and receive subsidies from the Regional Council

## Transepisteme, technological dynamic , adaptation



**fig 5: Transepistemic process**

The T1, T2 technologies belong to the CRITT. They are the fruit of their finalized research working, these technologies require a specific know-how and must be adapted to industrial application backgrounds.

The T1 technology has been evolving in time, it incorporates the inputs of the upstream research, the technical inputs of other fields that can be integrated in the methodologies. The  $TT1_{t1}$ ,  $TT1_{t2}$  technology T1 transfer at time  $t1$ ,  $t2$  of are for different fields companies ( $E_i$ ), the CRITT engineers have to integrate the technical data of the new application background, hence proceed to adaptations to the new field, work in close collaboration with the engineers or technicians of the firm for the transfer to be fully carried (training, technical help, new organization...)

The technology under the control of the transfer center is sometimes a system, including components issued from various scientific or technical fields. Then, the engineers-researchers of the CRITT must then start cross *epistemic* investigation in order to incorporate all the technological breakthrough of each different discipline to the new system.

The type of cooperation varies from a simple action (transfer of the technological knowledge) to a more complete program of transfer with implementation of the new technology, training of staff etc. When the transfer is an unusual implementation in a specific field, the collaborators (CRITT and industrialist) register a patent. The contract is the judicial act that unites both collaborators, but the means of coordination often requires a joint work during the period of transfer and even further for a determined period of stabilization.

Two examples which have been handled by the Mechanical Engineering CRITT of Toulouse :

- Self-acting seeding technology transfer in biological culture pipettes to an automatic chicken egg preventive vaccination .
- Transfer for a paper folding to a quick continuous printer which was in alveolate aluminium, replaced by lighter and resistant carbon pieces from aeronautics material.

## 4. Conclusion :History Matters:

Leydesdorff demonstration is based on the capacity for communication between the various spheres. The capacity to communicate or to translate, can only be one of the elements of cooperation - can we imagine cooperation between entities able to understand each other but deprived of any common objectives ? We used this model, and we analyzed functional systems (systems of communication, systems of translation) which extend beyond problems of communication. We consider that institutions including these systems have other methodologies and other concepts which we shall analyze and which will enable us to improve the model. We have to annualize the causal sequence, “uncertainty – organization” to understand the emergence, the stability, the evolution of an institution underlying in various formal or non formal ways cooperation between researchers and industrialists.

Some cooperations rather target the integration of the shared research activity, others follow the translation approach, translation between the academic world mastering a technology (and the scientific knowledge associated ) and industrialists who do not want this relationship to go on for ever.

The organization of cooperation follows an evolutionist process which leads to institutional arrangements. In this process, we have stressed the pertaining points to learning phenomena, proximity, a set of elements which induce path dependency. The governance plays a part through its ability to provide incentives to actors and to propose an institutional solution. This part is important in the triple helix model..

Furthermore, we think the limit in time of the process is an essential feature of the coordination process. It is the main factor to understand an institutional and organizational given situation<sup>17</sup> [Quéré M. & Ravix J.L. 1997].

The different institutional and organizational processes vary in time and are the result of specific training, accumulated experiences. They refer to situations more or less coherent and adapted.

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<sup>17</sup> Quéré M& Ravix on the emergence of organizations refer to the works of Richardson (1960) on the theory of the adjustment of economy "in which the temporality of processes plays a key role in the determination of the "order" and the "stability" of the real economic world"

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