From Key-technologies to Key-competencies

Scientific and Technological Competencies at the Regional Level
related to the French "Key-Technologies" Exercises

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Abstract:

This contribution draws from the OST's exercise "*Scientific and Technological Competencies at the French Regional Level*" sponsored by the French Ministry of Industry. Firstly, it describes the exercise as it took place. Secondly, it presents the methodology adopted at OST[1] in order to map scientific and regional competencies, as well as the main results and some examples of the available information. Finally, we conclude with some possible extensions and perspectives of mapping scientific and technological competencies related to key-technologies exercises.

Keywords:
Key-technologies, key-competencies, foresight methodology, mapping, scientific and technological competencies, regions, S&T indicators.

Biography of the author:
Yann CADIOU, born in 1971, French nationality. Yann Cadiou holds a PhD in economics at Paris VII University (thesis on a comparison between French and Japanese innovation system in the context of globalisation). As Project Manager at Observatoire des Sciences et des Techniques (OST) since 2001, his main research areas are the macroeconomics analysis, the trajectories of national research and innovation systems, science-technology-economy relationships, Japanese and South-eastern Asian countries economies. He works on OST's indicators and is responsible of the studies at the regional level. He is also particularly in charge to develop new indicators concerning the knowledge base economy. On the methodological side, his works concern new developments of innovation system analysis based on data analysis.

Introduction:

In the international economic and social context of globalisation, the limited public budget, the new needs of public authorities and of private sector, it is necessary to develop systematic long-term views, and to identify emerging technologies and areas of strategic research, because of the largely recognised key-role of technology in the economic growth.

[1] See Esterle and Laville, OST (2001).

Meanwhile, technology presents new challenges for competitiveness in terms of risk and opportunity, therefore it is necessary to reduce uncertainty, and to optimise use of the financial resources.

Further, public authorities as well as the public sector must ensure economic growth, employment, innovation, quality of life, allocation of limited resources, and they need useful tools in order to guide future technological development, determine economic, scientific and technological priorities, and create a common vision of socio-economic trajectories.

In this context, the French Ministry of Industry sponsored the "key-technology for year 2000[2]" study in 1993-1994, and a second "key-technology for 2005[3]" for the French Industry in 1999-2000. Those French foresight exercises had three main objectives:

- the identification of key-technologies;
- the guide for government policy in fostering appropriate technological solution and informing companies of future technological change to remain competitive;
- the evolution of the scientific and industrial position of France compared with partners and concurrent countries.

The questions addressed were always the same: *"what are the important technologies for national industries? What is the French position concerning those technologies? What should be the technological priorities*?"

This paper explains the passage from the two French key-technology exercises to the mapping of scientific and technological competencies at the French regional level realised by the OST. Indeed, after the Ministry of Industry's identification of key-technology work and the key-technologies characterisation, a study has been asked to the OST in order to identify and localise competencies of scientific fields and technological areas (at the French regional level) related to the key-technologies 2005, in comparison with the French foresight exercise.

This attempt does not exclude different debates on the key-technology concept because different interpretations exist, but this discussion is not the purpose of this paper. In fact, the French exercise approach has clearly chosen to define key-technologies as "*technologies that are important for the future development of the economy of a country in the medium term*". Further, there is a first reference to the technology dynamics and not directly to the attractiveness or the impact on competitive positions. We do not discuss the real nature and the role of technology, even if it is a key question.

In the first part of this paper, we will only summarise the context, the objectives, the methodology and the main results of the two French key-technologies exercises, essentially by interpreting different works. The second part will explain the main methodology elements of the OST's work based on the key-technologies experiences. In the third part, we will present the main results and some examples of the available information. We will conclude with some possible extensions and perspectives of

[2] Ministère de l'Économie des Finances et de l'Industrie [2001], France.
[3] Ministère en charge de l'Industrie [1995], France.

mapping scientific and technological competencies related to key-technologies exercises.

I. Summarise of context, objectives, methodology and main results of the two French key-technologies exercises

The purpose of this part is not to discuss if key-technology 2000 and 2005 exercises really are a foresight exercise or not. Of course, they only concerns long term in a very limited sense (years 2000 and 2005 and not the year 2030 for example). It also only creates effective interactions among a diversity of actors in a limited sense (it provides a technology study presented one by one). It is not a high level of elaboration of the objects under debates because the objective is not to elaborate explicit scenarios for the future. Those considerations are not discussed here; the most important is that the approach aims to identify those technologies, which represent a major stake for the French industry. This approach characterises the international strengths and weaknesses of the more developed countries and provides making policy recommendations.

We summarise, by using Bourgeois [2000; 2001], Barré [2001], Gasquet-Delattre [2001], Duran [2000]…, the context, the objectives, the methodology and the main results of the two French key-technologies exercises (key-technology 2000 and key-technology 2005), for which the target audience is the Minister of Industry, the Industry, and public research institutions.

The French view of technology foresight is related to the Ministry of Economy, Finances and Industry missions, and is made in an industrial short-term and market-driven perspective. The objective is to involve leading researchers and entrepreneurs. In two cases, the implementing agency is the OTS of the Ministry in charge of Industry, which is in charge of the methodology definition, implementation, publication of results and participation in working group as observers.

1. Key-technology 2000 exercise (horizon/time scale: 2000-2005): overall presentation

The key-technology 2000 exercise is a set of meso analysis. The results, the modes of presentation and the recommendations are presented in a book with chapters on trends and with a list of detailed keys technologies (strengths and weaknesses)[4].

The explicit objectives are:

- to evaluate scientific and industrial position of France compared to other countries and to study technological dynamics;
- to bring elements for research policy-making a decision-making centre or headquarter in order to foster appropriate technological solutions;

[4] For a larger presentation see IPTS [2001].

- to help French firms in identifying critical technologies, in informing companies of the future directions of technological changes in order for them to remain competitive;
- to have a more systematic approach to priority setting.

It is also a communication tool for the Minister. The actual result and impact result in a list of 105 key-technologies, a list of 136 important technologies and the emergence of the importance of the accompanying technologies concept ("soft technologies").

Concerning methodology, working groups were composed of experts who have used the notions "*atouts and attraits*" (winning cards and attractiveness) and notion of key-factors of success. In this case, not much attention was given to social needs. The exercise was very technology and industry oriented. The targeted sectors were:

- health and environment;
- services and communication;
- transport;
- life sciences;
- information technologies;
- energy;
- soft technology;
- materials associated technologies.

The method used to identify areas and questions was based on the consultation of experts and the work of steering committee. The steering committe of about 20 persons was chaired by Mr. Jean-Jacques Duby[5], who was responsible of the methodology[6], the finalisation of a list of key-technologies and the recommendations to the Minister. *Batelle* and *Bipe Conseil* were consultants and Mr. Dominique Deberdt was the project manager.

Eight criteria for the selection of technologies were set up. Almost 700 (candidate) technologies were identified, through the interaction of sectoral experts panels divided into "supply" and "demand" orientation.

At another stage, the 136 most important technologies were selected through clustering of the candidate technologies and application of the criteria. The 136 critical-technologies were classified in five groups, depending on the action to be taken:

- need for more RD efforts, from public and industrial research;
- need for better diffusion of the technology;
- attention to be given to normalisation and public procurements aspects;
- initiatives to be taken by industry regarding collaboration, also with public research;
- direct responsibility of industry through normal market mechanisms.

[5] Scientific director of UAP (Union des Assurances de Paris). He is today SUPELEC Director and chairman of the OST's Board.

[6] The steering committee and working group (200 persons and 10 working groups) of experts choose the categories of consultees by contacting consultants and by using the services of the State secretary for Industry, who establish a list of experts coming from public research and industry (research, marketing…). The consultees were consulted by working group's discussions (20 persons) with one consultant to animate the discussions and take notes, plus a few interviews. The gathering information is based on "veille technologique".

Finally, the French and European positions have been characterised with an analysis of the "success factors" concerning the 105 key-technologies.
In 1997, an extension of the first study was published in order to provide for basic information needs for strategic analysis. Indicators of diversity of application, position in the technological life-cycle, intensity of competition, market growth rate and entry cost were provided as well as a set of 136 short files presenting:

- a more detailed description of the technology and its major functions;
- sectors, markets, products concerned and market shares of the major competitors;
- short, medium and long terms perspectives of developments of the technology, with identification of the actors of technological supply.

The main lessons which have been provided through the first exercise are the necessity:

- to define the concept of technology;
- to reduce the number of industrial sectors; to include wide ranger of expertise;
- to collaborate with a consulting group;
- to reduce the number of experts in working groups;
- to coordinate working groups (with standardised terminology, with specific allocated technology for each group, technology "size" harmonised.

2. Key-technology 2005 exercise (horizon/time scale: 2005-2010): overall presentation

The second study (published in 2000) clearly made significant efforts to enlarge the interactions (more than 650 experts[7] of different categories involved), to extend the concept of technology towards "soft" technologies, and to be serious about the demand and social needs.

This exercise called upon 150 experts divided in 8 thematic sub-groups, plus the additional "interactivity and quality group"[8]. Each group was composed of about 12 members, who gathered for 4 to 8 half-a-day meetings.

After the selection of consultants and experts[9], during the production step the objective has been to identify "candidate technologies" and to select the most relevant technology for each industrial sector. The methodology was close to the first exercise but with an additional second circle of expert through internet[10]. The 8 thematic working groups and

[7] After selecting consultant, the experts were selected for working groups through a co nomination process out of about 650 names from a list provided by consultant and sectoral management of Ministry of industry. The remaining 500 additional experts contributed to evaluate and qualify the candidate technologies both through mail questionnaires and through an Internet Forum.

[8] See Durand [2000].

[9] Philippe Bourgeois and Philippe Zenatti (Ministry of Industry) were responsible for the methodology, and finalisation of a list of key technologies. The consortium of consultants was led by *CM International Group*, and in particular by Thomas Duran.

[10] The Internet forum has been used to avoid expert selection bias and to enlarge the expertise base. The forum was opened to public after registration of password allocation. Missions were to comment working group reports and to provide new perspectives.

another transversal group (interactivity and quality) were the following:

- biotechnology, health care, food& agriculture;
- information and communication technologies (ICT);
- material and chemicals;
- environment and energy;
- Public works, housing, construction;
- transport, air transport, space;
- consumption of goods and services;
- design, logistics, manufacturing, management;
- interactivity and quality[11].

Technologies have been discussed as regards the corresponding functional needs on the demand side, and on the base of various national similar exercises using different methodology approaches like Delphi, panels… (French Ministry of Industry [1995]; Office of Sciences and Technology [1995]; Office of Sciences and Technology Policy [1995]; NISTEP [1997].

Each member of the 8 thematic subgroups used three initial inputs in order to provide potentially "technology items" (1. A list of the 136 key-technologies identified 5 years earlier; 2. The results of a literature survey on important new themes for each area; 3. A summary of main social trends and drivers on the demand side). 600 items were proposed). The consultees were consulted through a working group (20 persons) with one consultant leading the discussions and another consultant taking notes, plus a few interviews and internet consultations. The priorities were discussed in working groups and the steering committee made the final choices. The consensus generation was obtained by discussions, and brainstorming sessions using the well known meta-plan in subgroups.

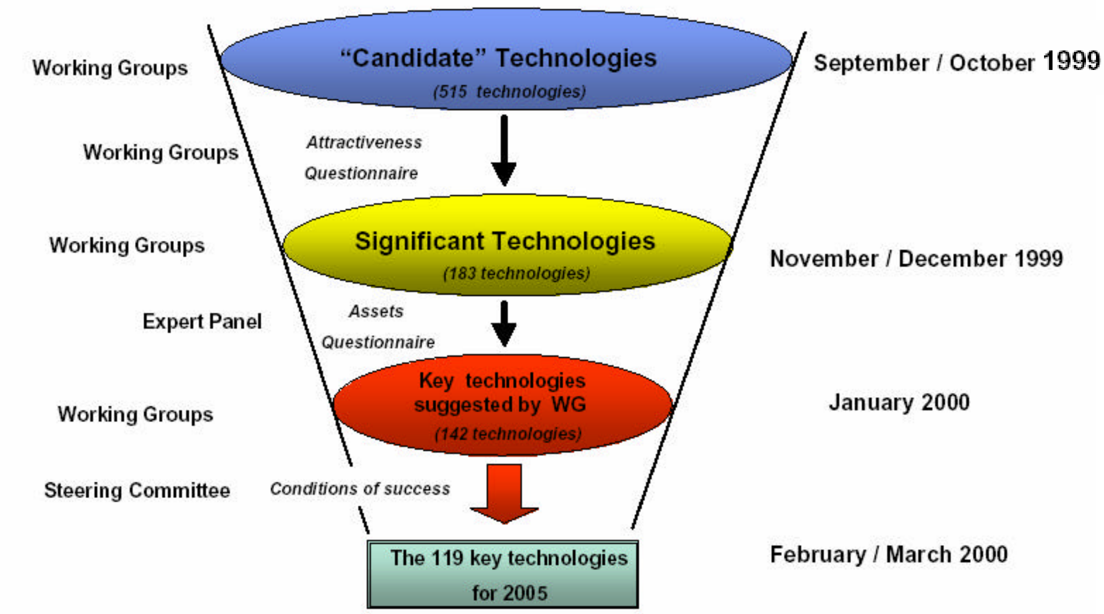
The 119 key-technologies were selected through two principles: attractiveness and assets/competitive position. Eight expert's reports on technologies of the future and specific recommendations were produced.

The following figure illustrates the process of technologies selection and the agenda. About 70 half-a-day meetings were organised over 15 months time span. The work started in April 1999, candidate's technologies appeared in October 1999, the key-technology appeared in March 2000 and the final report was presented to the Ministry of Industry in October 2000 (see figure 1).

200 items were pre-selected by using a first criteria related on attractiveness for both France and the European Union. A key-technology corresponds to 5 criteria of attractiveness selected by the steering committee:

[11] The interactivity and quality group was composed by 10 members with diverse background profiles. The objective and missions were to ensure quality and coherence of project, and provide consulting to project team.

Figure 1. The process of technologies selection and the agenda of the French key-technology 2005 exercise



Sources: French Ministry of Industry [2005].

1. Economic challenge: industrial and economic stakes for the technology:
   - current and future market size;
   - opportunity to build / defend a competitive position;
   - potential of dissemination in firms;
   - potential for mass production and cost cutting;
2. Environmental challenge: environment preservation:
   - sustainable development;
   - energy and natural resource conservation;
   - emission control and waste management;
   - potentially adverse effects of the technology on environment;
3. Stakes in society - social needs:
   - health, food safety and hygiene;
   - aging;
   - culture, education, training;
   - potentially adverse effects;
4. National and European challenges: National and European Security:
   - security, defence;
   - industrial independence;
5. Dynamics of technology:
   - lifting technology bottleneck and/or lock-up;
   - combinatory potential with other technologies;
   - propensity of technology to be absorbed by firms;
   - research enhancing technology;
   - other.

Group experts were asked to establish a typology of the candidate technologies (selected, undecided and rejected categories). The most difficult choices essentially concerned the undecided candidate's technologies and the problems have been solved through changing of item's labels or arbitration to the steering committee. This process leads to 200 candidate's technologies. Trough a second list of criteria related to the competitive position of French and European players, 119 key-technologies have been selected and described in detail in the final report. The concerned criteria were the following:

1. Scientific and technological capabilities/positions
    - presence of a scientific competence base / R&D capabilities;
    - knowledge base and capabilities for related or competing technologies;
    - favourable institutional setting: education, technology transfer, technical assistance;
    - existence of active and productive networks, including within the EU frameworks RTD program;
    - other;
2. Industrial and Market Position:
    - industrial capability on the technology
    - capability on related or competing technology technologies in EU firms
    - EU firms competitive positions vs market leaders
    - favourable institutional setting: norms and standards, regulation, "lead-market" to tiger and test a sequence of applications for technology
    - existence of active and productive networks; alliance, clusters …
    - availability of resources to implement and to leverage the technology (industrial and commercial investments)
    - other.

In order to evaluate conditions of success, five criteria were identified:
- commitment of key players;
- presence of "flagship" companies;
- possibility of alliance;
- sensitivity to public sector incentives;
- social acceptability.

To conclude on the methodological side, during the final phase, the steering committee, which was appointed to monitor the foresight exercise and was constituted with various ministerial industry departments, public agencies, public research centres, have produced formal presentations of deliverables, outputs and deliverable reviewing, have helped to finalise selection of key technologies, and have draw up the recommendations. Finally, the precise objectives, the diversity of inputs, the criteria to evaluate attractiveness, the assets and key factors of success, the presence of interactivity group in the exercise, and the quality of reports in working groups, have constituted the strengths of the exercise. Meanwhile, the selection of experts, the Internet forum, the lobbying effects, and the division of industrial sectors appeared as the main limitations of the exercise.

On the other side, the following figure summarises the main results of the French Key-technology (2005) exercise from the point of view of Bourgeois [2000b] .

Figure 2: summarize of main results of the key-technology (2005) foresight

Main tendencies of the technological development

- a generalised diffusion of the ICT;
- bio-technologies still in phase of emergence;
- organisational technologies in the heart of the innovation process;
- central role of "cross road" technologies ;

Information and Communication Technologies (ICT)

- development driven by "technology push ";
- increasing need for reliable fast Internet and wireless technologies;
- "industrialisation" of software development;

Materials and chemicals

- simultaneous product and process innovation;
- increased role of "customer pull";
- new materials developed at molecular level;

Construction, public works, and housing

- adapted to demographic and sociological trends;
- adapted to changing conditions of work and leisure;
- environmental considerations move to the forefront;

Environment and energy

- environment: technology is both source of and solution to pollution;
- energy:
  - to diversify the modes of energy production (in particular to save non renewable energies);
  - to control the storage of renewable energies (sun, wind);
  - to reduce the consumption of energy;

Transport, aviation, and space

- a request for transport of people and goods increasing;
- a strong environmental constraint;
- a broad diffusion of electronics;

Consumer goods and services

- consummation of mass to the personalised consummation and with made to measure;
- the consumer needs to be reassured ("mad cow", chicken with dioxin…);
- if the consumer accepts the technological innovations, those must facilitate this life;

Design, production and logistic management

- systems designed to meet individual and changing requirements;
- importance of flexible production lines;
- improved management of information and product flows;

Conclusion

- no technology gap detected;
- ICT fundamental to all industrial sectors;
- technological solutions required for environment;
- socially acceptable bio-technologies is a future challenge;
- key-role of organisational technologies to maximise knowledge management and competitiveness;
- importance of client focused technologies.

Sources: Bourgeois [2000].

II. The OST Study of scientific and technological competencies at the regional level

The objective of the OST study[12] is to localise and map scientific and technological competencies at the French regional level to develop "key-technology 2005" and to realise strategic analyses by using tools linked to reliable, reproducible and comparable indicators through space and time.

By using those indicators, the analysis of the strengths and weaknesses of scientific and technological competencies of each French region enables us to know what strategy a region could develop (for example attractiveness and/or cooperation with its neighbouring regions or other regions). The same analysis is also possible for the entire European region at the Nuts 3 level but has not been realised yet[13].

The OST study is divided in two steps.

The first step consists in the identification of adequate classification through a closed collaboration between experts of the Ministry of Industry and the OST. In particular, we establish a correspondence between the scientific publications classification, the European patent classification and the two scientific and technological competencies classifications. In this initiative, one constraint is to develop a "meso" approach. The objective is to go further than a useless macro or micro overview based on results too global or on a number of "micro-results" too great.

The second step consists in the production of bibliometric indicators:

- scientific competencies were measured by the number of publications recorded in the ISI's Science Citation Index (SCI) - COMPUMATH databases (for a proxy of scientific activities)
- and technological competencies was measured by the number of European patents published, recorded in the European patents (EPAT and ERUO-PCT) data base (for a proxy of technological activities).

At the end, even if the kind of analysis aims to be as objective as possible, this work inevitably leads to a relatively subjective approach, but there is no perfect classification. Of course, each of these information sources presents some bias. Therefore interpretations and analyses must be done with a certain amount of precaution because

[12] See "Indicateurs régionaux de potentiel Science et Technologie dans les technologies clés 2005, study realised for the French Ministry of Economy, Finances and Industry, by Laurence Esterle and Françoise Laville (with the contribution of Nelson Teixeira and Vincent Charlet), Paris, France, 2001. This study is mainly based on standard OST methods, summarised in the methodological annex of the OST reports (OST Report 2002, Economica, Paris, France, 2002).

[13] EUROSTAT has established a "*Nomenclature d'Unités Territoriales Standardisées*" (NUTS) for the EU member countries (cf. EUROSTAT 'the regional dimension of RD innovation statistics - regional manual', Luxembourg, 1996).It is organized in hierarchical descending order: NUTS-0 are the countries themselves, NUTS-1 the 'large regions', NUTS-2 smaller ones and so on. In the 15 member countries, there are : a) 1029 NUTS-3 regions, of which: 177 have less than 0,1 Mh (million inhabitants), and 14 have more than 2 Mh; b) 194 NUTS-2 regions, of which: 1 has less than 0,1 Mh , and 50 have more than 2 Mh. In order to have a relatively comparable average size of the regions among the countries, we can use the NUTS-2 regions for some countries, the NUTS-3 some the others, plus NUTS-0 for Luxemburg.

of the adopted methodological choices and also because of the problem of relevant information related to the significant number of data characterising the scientific and technological fields analysed.

1. Scientific fields as a proxy of scientific competencies at the regional level

Scientific fields of competencies (24 fields and 6 larger fields are calculated by the aggregation of the 24 fields) related to the "key-technology 2005" foresight exercise, are based on:

- scientific publications counted in the Science Citation Index (SCI) and Compumath databases;
- each file describing the key-technology constructed by the French Ministry of Industry;
- additional expertises.

All steps are validated by the French Ministry of Industry.

Each technology corresponds with one of some 170 ISI's scientific specialities, but only 85 specialities among 170 are related to the 119 key-technologies 2005. Those 85 specialities are aggregated into 24 scientific fields of competencies and results are presented with 24 files, which all start with a presentation of the concerned key-technologies.

A scientific field of competencies corresponds with a set of key-technologies. A key-technology mobilises a set of scientific competencies (fields).

For example, the "gene engineering" field concerns the following key-technologies: transgenese, detection and analysis of the environmental risks related to genetically engineered foods and organisms, gene therapy, animal cloning, grafts, cellular therapy, bio-artificial organs. The "transgenese" key-technology necessitates the following scientific competencies (fields): animals and plants biology, cellular and molecular biology, gene engineering.

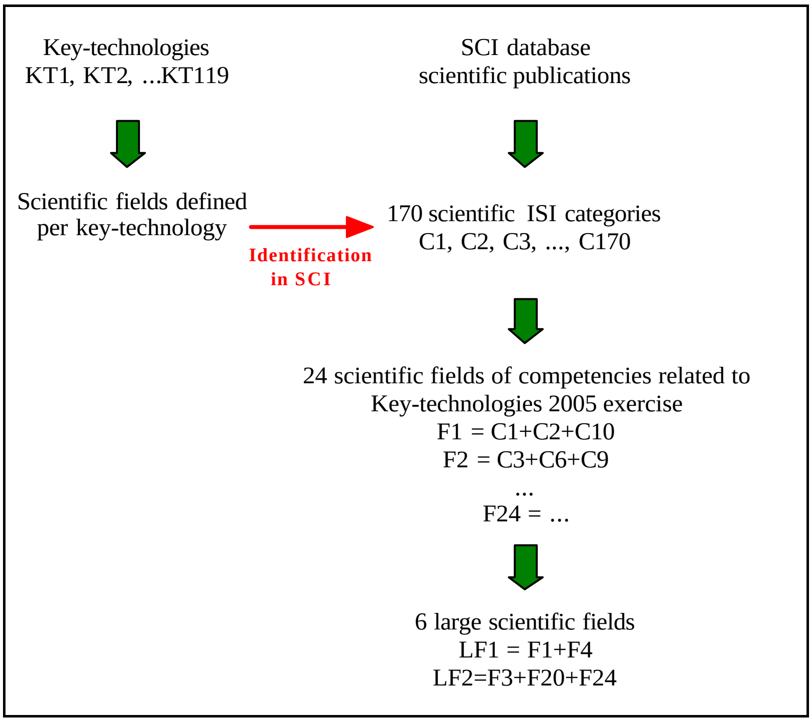
For each field and for example the years 1995 and 1998[14], we can calculate[15]:

- national share of each region in scientific publications in each field e.g. the number of regional publications in the considered field divided by the total number of French publications all fields combined.
- we have also calculated the density index as regards of population size e.g. the number of publication divided by the regional population number.

[14] Calculating have been realised by averaging method: for example, 1998 is the average of the years 1996, 1997 and 1998.

[15] Today, we are able to calculate those indicators until the year 2001.

Figure 3: Identification of scientific fields of competences (matching the 119 key-technologies with the 170 ISI scientific categories)



We traditionally use fractional counting method. For a publication with three co-authors, we count 1/3 of publication for each author. For example, if a publication has three co-authors from three distinct regions, we count 1/3 of publication for each region.
When the number of publications per region is less than 5, indicators are provided but must be interpreted with precaution. In a scientific field, when the total number of French scientific publication is less than 300 for 3 years, we have only calculated national shares of regions, and not insignificant density indexes or evolution indexes.

1.1. Scientific competencies: detailed file example

Each file corresponds to a scientific field of competencies and reminds the concerned key-technologies. For each file, we realise the same brief analyses:

1. we present the French world share in scientific publications for the field and the year considered as regards the French position all fields combined (nearly 5%).
2. the most "active regions" in 1998 in decreasing order.
3. the most "active regions" between 1995 and 1998, and remarkable dynamics of some other regions.
4. the most important regions in decreasing order of their density (population) characterisation. The rank of Île-de-France (the more developed region in France) is systematically mentioned.
5. two maps respectively show the regional dispersions and evolutions of the national shares between 1995 and 1998 .

The two following tables present the example of one file: the case of "interconnections and interface components".

Figure 4a. Scientific competencies related to key-technologies - example of a detailed file: the case of biotechnology

Technologies clés concernées :

- procédés biologiques et biomimétiques de synthèse de minéraux et polymères
- développement de techniques de diagnostic et de traitement des sols
- détection et analyse des risques pour l'environnement liés aux OGM
- thérapie génique
- criblage des molécules actives
- greffe d'organes
- thérapie cellulaire
- organes bio-artificiels
- miniaturisation des instruments de recherche médicale
- traçabilité
- biopuces, biocapteurs

Les principaux résultats

- Part mondiale de la France en 1998 : **5,0 %**
- Indice de spécialisation de la France dans le domaine par rapport à l'ensemble des publications scientifiques toutes disciplines confondues en 1998 : **0,95**

- Régions les plus actives en 1998 :
  - Ile-de-France (31,5 %)
  - Rhône-Alpes (9,2 %)
  - Languedoc-Roussillon (7,6 %)
  - Midi-Pyrénées (6,7 %)
  - Provence-Alpes-Côte d'Azur (6,7 %)

- Evolution des régions les plus actives entre 1995 et 1998 :
  - **En augmentation** : Ile-de-France (+ 2 %), Languedoc-Roussillon (+ 1 %), Provence-Alpes-Côte d'Azur (+ 34 %)
  - **En diminution** : Rhône-Alpes (- 9 %), Midi-Pyrénées (- 7 %)

- Evolution observée pour d'autres régions entre 1995 et 1998 :
  - **Forte augmentation** : Pays de la Loire (+ 50 %), Champagne-Ardenne (+ 46 %), Poitou-Charentes (+ 43 %), Basse-Normandie (+ 41 %)

- Densité scientifique élevée (> 150) :
  - Languedoc-Roussillon, Ile-de-France, Midi-Pyrénées

Tableau 1 : part nationale (%) en 1998 et 1995 ; 1998 en base 100 pour 1995 ; densité scientifique par rapport à la population des régions françaises dans le domaine "biotechnologies"

Regions	Part/France (%) 1998	1995	1998 en base 100 pour 1995*	Densite scientifique 1998
Ile-de-France	31,5	30,8	102	171
Champagne-Ardenne	1,2	0,8	146	54
Picardie	2,6	3,7	72	84
Haute-Normandie	1,2	1,6	79	42
Centre	2,3	1,9	121	55
Basse-Normandie	0,7	0,5	141	28
Bourgogne	2,4	3,1	77	90
Nord-Pas-de-Calais	2,9	2,7	105	43
Lorraine	4,1	5,7	72	107
Alsace	3,8	4,9	78	134
Franche-Comte	0,8	1,0	86	45
Pays-de-la-Loire	4,5	3,0	150	84
Bretagne	4,6	3,8	122	96
Poitou-Charentes	1,1	0,7	143	39
Aquitaine	3,7	4,0	91	76
Midi-Pyrenees	6,7	7,2	93	159
Limousin	0,7	0,2	*296*	60
Rhone-Alpes	9,2	10,1	91	98
Auvergne	1,5	1,6	95	69
Languedoc-Roussillon	7,6	7,5	101	201
Provence-Alpes-Cote d'Azur	6,7	5,0	134	90
France	100,0	100,0	100	100
Nombre de publications	1 470	1 031		

donnees ISI (SCI, COMPUMATH), traitements OST

••• * la typographie "*chiffre*" indique des valeurs non significatives (nombre de publications trop faible)

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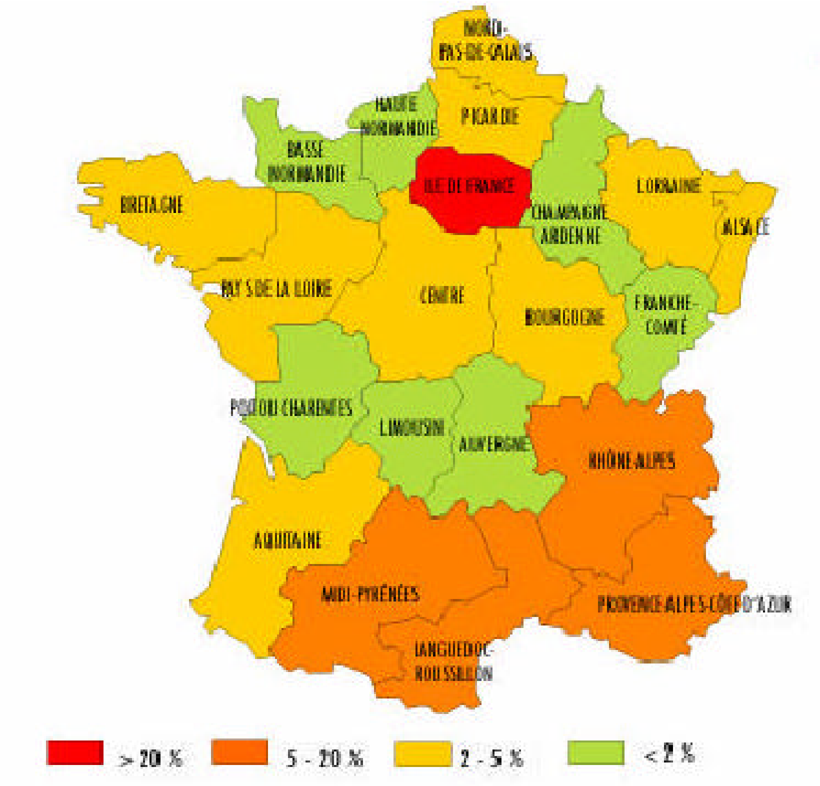
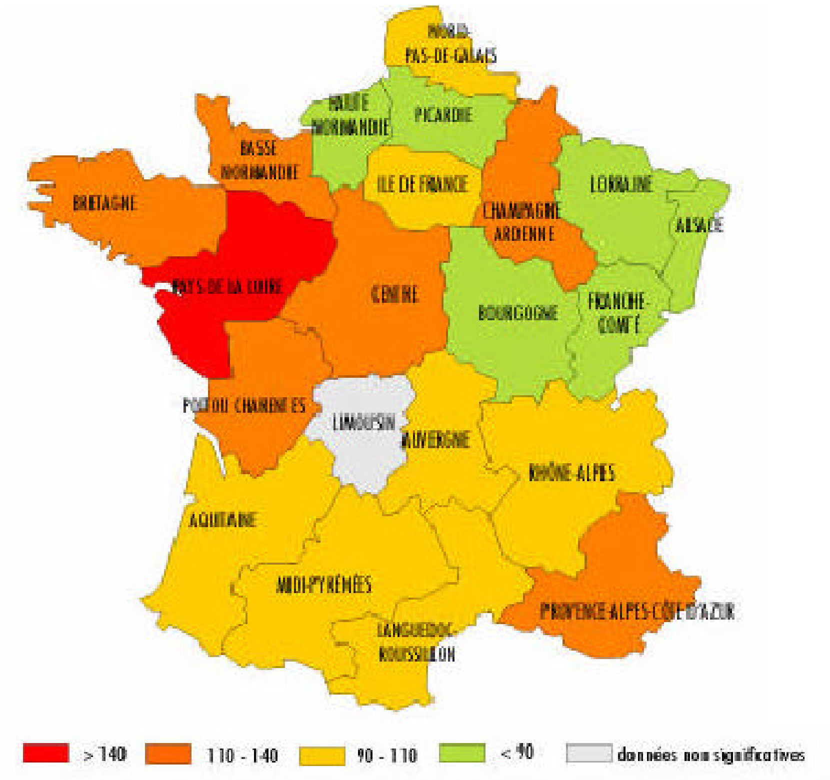
Figure 4b. Scientific competencies related to key-technologies - example of a detailed file: the case of biotechnology



carte 1 : publications scientifiques régionales en part nationale (%) (1998, biotechnologies)



données ISI (SCI, COMPUMATH), traitements OST

carte 2 : évolution des parts nationales des publications scientifiques régionales (1998 en base 100 pour 1995, biotechnologies)

1.2. Scientific competencies: latest results for the year 1999

In the latest OST report (2002), we have actualised the data. The following tables present the main results and particularly:

- the inter-regional distribution and specialisation index in scientific competencies related to key-technologies 2005 (1995, 1999 and 1999 base 100 for the year 1995).
- the inter-regional distribution per large scientific field of competencies related to key-technologies 2005 (1999).

Table 1. Inter-regional distribution and specialisation index in scientific competencies related to key-technologies 2005 (1995, 1999 and 1999 base 100 for the year 1995)

Régions	Inter-régional distribution (%)			Spécialisation in key-technologies		
	1995	1999	1999 (base 100 = 1995)	1995	1999	1999 (base 100 = 1995)
Ile-de-France	41,4	36,8	89	0,97	0,97	100
Champagne-Ardenne	0,6	0,7	110	0,97	0,96	99
Picardie	0,7	0,8	126	1,04	1,04	101
Haute-Normandie	1,2	1,3	115	1,02	1,04	102
Centre	2,0	1,9	95	0,92	0,90	98
Basse-Normandie	1,1	1,2	111	1,07	1,07	100
Bourgogne	1,2	1,3	105	0,99	1,00	101
Nord-Pas-de-Calais	2,9	3,4	117	0,97	1,02	106
Lorraine	2,9	3,1	106	1,03	1,06	103
Alsace	4,5	5,1	112	1,16	1,12	96
Franche-Comté	0,8	1,0	117	0,98	1,04	107
Pays-de-la-Loire	2,4	2,8	116	1,06	1,05	99
Bretagne	3,2	3,6	112	1,03	1,04	102
Poitou-Charentes	1,1	1,2	117	1,07	1,02	95
Aquitaine	3,7	3,9	105	1,05	1,03	97
Midi-Pyrénées	4,7	5,3	113	1,01	1,04	103
Limousin	0,6	0,7	118	1,03	1,02	99
Rhône-Alpes	11,3	12,0	107	1,02	1,03	101
Auvergne	1,5	1,6	107	1,14	1,05	92
Languedoc-Roussillon	4,6	4,8	104	1,04	0,99	95
Provence-Alpes-Côte d'Azur	7,2	7,1	99	0,94	0,97	103
France	100,0	100,0	100	1,00	1,00	100

données ISI (SCI, COMPUMATH), traitements OST | *rapport OST-2002*

We observe in 1999 that the first 4 regions as regards the national share (NS) of scientific competencies related to the key-technologies are: Île-de-France (NS = 36,8%), following by de Rhône-Alpes (12 %), Provence-Alpes-Côte d'Azur (7,1 %), and Midi-Pyrénées (5,3 %).

Île-de-France (NS = - 11%), Centre (- 5%), and Provence-Alpes-Côte d'Azur (- 1%) are the main French regions, which reduce their national between 1995 and 1999.

Among the first 5 regions, Alsace is the only one to have a specialisation index higher than 1,12. Four others regions have a specialisation index equal or higher than 1,05: Basse-Normandie, Lorraine, Pays-de-la-Loire et Auvergne.

Table 2. Inter-regional distribution per large scientific field of competencies related to key-technologies 2005 (1999)

	Inter-régional distribution (%) per Large scientific field of competencies (1999)						
Regions	Biology-biotechnology	Medical sciences	Chemistry	Physics	Engineering sciences	Mathematics and informatics	All fields combined
Ile-de-France	*36,7*	**44,9**	*27,5*	*36,7*	*35,5*	**40,1**	36,8
Champagne-Ardenne	**0,8**	*0,6*	**0,8**	**0,8**	*0,4*	*0,6*	0,7
Picardie	*0,8*	**0,9**	**0,8**	*0,5*	**0,9**	**1,1**	0,8
Haute-Normandie	*0,9*	**1,4**	**1,8**	*1,3*	*0,8*	**1,6**	1,3
Centre	**2,5**	*1,6*	*1,7*	*1,5*	**2,3**	*1,5*	1,9
Basse-Normandie	*0,6*	*1,0*	**1,9**	**2,0**	*0,4*	**1,4**	1,2
Bourgogne	**1,6**	*1,1*	**1,5**	*1,2*	*0,6*	*0,9*	1,3
Nord-Pas-de-Calais	*3,0*	*3,3*	*3,2*	**3,8**	**3,9**	**4,0**	3,4
Lorraine	*2,4*	*2,2*	**4,3**	*3,0*	**4,2**	**3,7**	3,1
Alsace	**5,5**	*4,3*	**8,2**	*3,1*	*2,6*	*2,8*	5,1
Franche-Comté	*0,4*	*1,0*	**1,0**	**1,6**	**1,2**	**1,4**	1,0
Pays-de-la-Loire	*2,5*	*2,8*	**3,5**	*2,4*	*2,1*	*2,5*	2,8
Bretagne	**4,1**	*2,0*	**3,8**	*3,2*	**5,6**	**4,3**	3,6
Poitou-Charentes	*1,1*	*1,0*	**1,7**	*0,8*	**1,6**	**1,4**	1,2
Aquitaine	*3,5*	**4,3**	**4,5**	*3,8*	*2,5*	*3,8*	3,9
Midi-Pyrénées	**5,6**	*3,6*	**6,0**	*5,0*	**7,6**	**5,8**	5,3
Limousin	*0,6*	**0,8**	**0,7**	*0,7*	**1,0**	*0,5*	0,7
Rhône-Alpes	*9,4*	*8,9*	**14,9**	**18,8**	**14,2**	*10,4*	12,0
Auvergne	**2,1**	*1,5*	*1,5*	*0,8*	*1,3*	*1,4*	1,6
Languedoc-Roussillon	**7,2**	*4,1*	**5,3**	*2,9*	*2,9*	*2,2*	4,8
Provence-Alpes-Côte d'Azur	**8,0**	**8,1**	*5,1*	*5,8*	**8,1**	**8,0**	7,1
France	100,0	100,0	100,0	100,0	100,0	100,0	100,0

données ISI (SCI, COMPUMATH), traitements OST *rapport OST-2002*

The aggregation of 24 scientific fields into 6 large scientific fields shows the diversity of scientific competencies distribution between French regions.
Île-de-France appears specialised in medical sciences with a national share close to 45%, and under-specialised in chemistry (NS = 27,5%). Rhône-Alpes is higher than its average all fileds combined (NS = 12%) in the physics (NS = 18,8%), chemistry (NS = 14,9%) and engineering sciences (14,2%).

Provence-Alpes-Côte d'Azur national share is equal to or higher than 8% in four large fields: biology-biotechnology, medical sciences, engineering sciences and mathematics-informatics. Midi-Pyrénées particularly appears specialised in engineering sciences (NS = 7,6%). Among the other regions, Languedoc-Roussillon presents a strong national share in biology-biotechnology (NS = 7,2%) and Bretagne presents scientific competencies related to key-technologies in engineering sciences (5,6%).

2. Technological areas as proxy of technological competencies at the regional level

Technological areas competencies (30 areas and 7 larger areas calculated by aggregation of the 30 areas) related to the "key-technology 2005" foresight exercise, are based on:

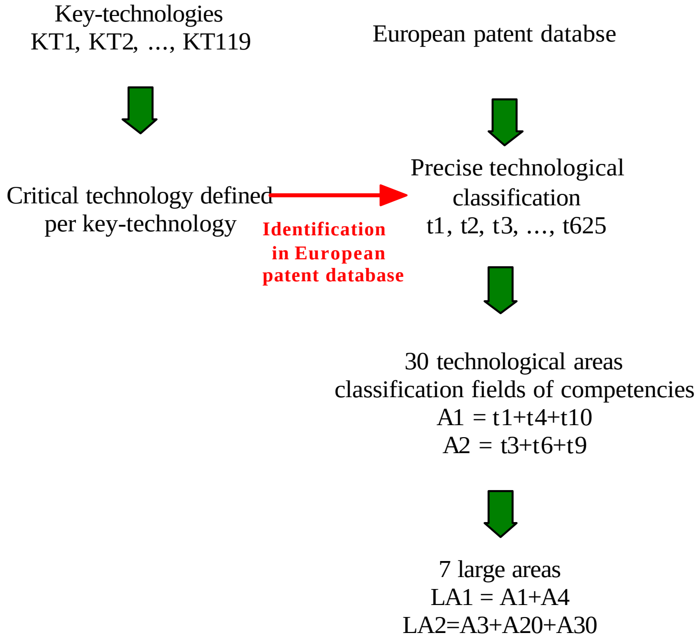
- European patents and patents from EURO-PCT from European patents database;
- each file describing the key-technology constructed by the French Ministry of Industry;
- additional expertises.

All steps have been validated by the French Ministry of Industry.
Each technology corresponds to one or more codes (among 625 codes) of the patent international classification. Those codes are based on:

- OST's works [2000] in the case of key-technologies close to the key-technology 2000;
- consultation of the "National Institute of intellectual property" (e.g. INPI) website[16], and mapping of the patents linked to the key-technologies and the most frequent codes from the patent international classification.

The considered codes are aggregated in 30 technological areas characterising technological competencies. Then each technological area of competencies is linked to a set of key-technologies. At the opposite, a key-technology mobilises a set of technological competencies (areas).

Figure 5. Identification of technological areas of competences (matching the 119 key-technologies with the 625 IPC sub-classes)



[16] www.inpi.fr

For each technological area and the years 1995 and 1998[17], we have calculated[18]:

- the national share of each region in European patent invented and EURO-PCT e.g. the number of regional patents invented in the considered area divided by the total number of French patents all areas combined.
- the density index calculated as regards the population size e.g. the number of patent divided by the regional population number.
- The indicators calculated in dynamics (e.g. between the two considered periods - base 100 = 1995).

We have also presented in the case of the 10 or 15 most active depositors (institutional actors in 1998) the number of European patents and the distribution as regards the total patent number. We have finally listed for the first "inventors regions" the most important depositors (with at least 5 European patents).

We traditionally use a fractional counting method. For a patent with three co-inventors, we count 1/3 of patent for each inventor. For example, if a European patent has three co-inventors from three distinct regions, we count 1/3 of patent for each region. When the number of patents per region is less than 2, indicators are only mentioned and must be interpreted with precaution. In a technological area, when the total number of French European patents is less than 100 for 3 years, we only calculate national shares of regions, and we exclude insignificant density indexes or evolution indexes.

2.1. Technological competencies: detailed file example

The following tables present an example of one file: the case of "interconnections and interface components". Each file corresponds to a technological area of competence and reminds the concerned key-technologies.

The main results have been established with similar criteria in each file.

- French world share in 1998 in European patent (inventors addresses) in the considered area and the specialisation index as regards the total European patent number all areas combined (France represents between 6 and 7% of the European patents and EURO-PCT all areas combined);
- the most active "inventors" regions (national share of the considered region higher than 4% in 1998 in the concerned area) in decreasing order;
- the most relevant dynamics between 1995 and 1998 and notable evolutions;
- the regions which have the higher 150 density indexes (population), cited in decreasing order;
- the total number of holders (institutional actors) and the reliable total patents number.
- the most active holders - share higher than 8%, and the 15 first holders national shares.
- Finally two maps present the regional distribution of the national share in European patents in the concerned area, and the evolution between 1995 and 1998.

[17] Calculation have been realised by an averaging method: for example, 1998 is the average of the years 1996, 1997 and 1998.

[18] Today, we are able to calculate those indicators until the year 2001.

Figure 6a. Example of a detailed file

2. Composants d'interconnexion et d'interface

Technologies clés concernées :

- composants d'interconnexion et d'interface

Les principaux résultats

- Part mondiale de la France (en inventeur) en 1998 : **6,6 %**, soit 346 brevets
- Indice de spécialisation de la France dans le domaine par rapport à l'ensemble des brevets inventés tous domaines confondus en 1998 : **1,03**

- Régions les plus actives en 1998 :
  Ile-de-France (38,2 %)
  Rhône-Alpes (19,2 %)
  Pays de la Loire (6,1 %)
  Midi-Pyrénées (4,9 %)
  Franche-Comté (4,5 %)
  Provence-Alpes-Côte d'Azur (4,3 %)

- Evolution des régions les plus actives entre 1995 et 1998 :
  En augmentation : Rhône-Alpes (+ 36 %), Midi-Pyrénées (+ 93 %), Franche-Comté (+ 53 %)
  En diminution : Ile-de-France (- 9 %), Pays de la Loire (- 37 %), Provence-Alpes-Côte d'Azur (- 33 %)

- Evolution observée pour d'autres régions entre 1995 et 1998 :
  Forte augmentation : Limousin (+ 240 %), Centre (+ 133 %), Bourgogne (+ 76 %)
  Forte diminution : Aquitaine (- 69 %), Bretagne (- 54 %), Champagne-Ardenne (- 51 %)

- Densité technologique élevée (> 150) :
  Franche-Comté, Ile-de-France, Limousin, Rhône-Alpes

- Déposants personnes morales français en 1998 :
  - nombre de dépsants : 109
  - nombre de brevets déposés : 317
  - les 15 premiers déposants : 60,3 % des dépôts du domaine

  - déposants personnes morales les plus actifs en 1998 :
    - FRAMATOME CONNECTORS INTERNATIONAL (19,7 %)

  - première région inventeur de FRAMATOME CONNECTORS INTERNATIONAL, situé en Ile-de-France : **Pays de la Loire**

Tableau 1 : part nationale inventeur (%) en 1998 et 1995 ; 1998 en base 100 pour 1995 ; densité technologique par rapport à la population des régions françaises dans le domaine "composants d'interconnexion et d'interface"

	Part France (%)			Densité technologique 1998*
Régions	**1998**	1995	1998 en base 100 pour 1995*	
Ile-de-France	**38,2**	42,2	91	208
Champagne-Ardenne	**2,5**	5,0	49	109
Picardie	**0,9**	1,2	75	30
Haute-Normandie	**3,1**	2,2	142	104
Centre	**3,7**	1,6	233	91
Basse-Normandie	**1,1**	0,3	*326*	47
Bourgogne	**3,4**	1,9	176	125
Nord-Pas-de-Calais	**0,4**	0,1	*708*	*5*
Lorraine	**0,7**	0,5	132	*18*
Alsace	**2,7**	2,2	123	95
Franche-Comté	**4,5**	2,9	153	241
Pays-de-la-Loire	**6,1**	9,7	63	116
Bretagne	**0,9**	2,0	46	19
Poitou-Charentes	**0,5**	0,8	69	20
Aquitaine	**0,4**	1,2	31	*8*
Midi-Pyrénées	**4,9**	2,5	193	117
Limousin	**2,5**	0,7	340	206
Rhône-Alpes	**19,2**	14,2	136	205
Auvergne	**0,0**	1,5	*0*	*0*
Languedoc-Roussillon	**0,0**	0,7	*0*	*0*
Provence-Alpes-Côte d'Azur	**4,3**	6,5	67	58
France	**100,0**	100,0	100	100
Nombre de brevets	**346**	392		

données INPI et OEB, traitements OST

••• * la typographie "*chiffre* " indique une valeur non significative (nombre de brevets trop faible)

Figure 6b. Example of a detailed file

Tableau 2 : les 15 premiers déposants personnes morales en nombre de brevets et leur répartition (%) en 1998 dans le domain e "composants d'interconnexion et d'interface"

Déposants personnes morales	Région	Nombre de brevets	Répartition (%)
FRAMATOME CONNECTORS INTERNATIONAL	Ile-de-France	63	19,7
SCHNEIDER ELECTRIC SA	Ile-de-France	20	6,3
ALCATEL	Ile-de-France	17	5,2
FRAMATOME	Ile-de-France	16	5,0
LEGRAND	Limousin	15	4,7
GEC ALSTHOM ELECTROMECANIQUE SA	Ile-de-France	9	2,8
POUYET SA	Ile-de-France	8	2,5
THOMSON-CSF	Ile-de-France	7	2,2
ENTRELEC SA	Rhône-Alpes	7	2,2
VALEO VISION	Ile-de-France	6	1,9
RADIALL	Ile-de-France	6	1,9
RAYCHEM PONTOISE SA	Ile-de-France	5	1,6
SYLEA	Ile-de-France	5	1,6
SIEMENS AUTOMOTIVE SA	Midi-Pyrénées	4	1,3
ARNOULD FABRIQUE D'APPAREILLAGE ELECTRIQUE	Rhône-Alpes	4	1,3
Total des 15 premiers déposants		191	60,3
Total déposants		317	100,0
données INPI et OEB, traitements OST			

••• le nombre total de brevets entre le tableau 2 ci-dessus et le tableau 1 peut différer sensiblement, car la base de comptage n'est pas la même :
tableau 1 : décompte des brevets par inventeur
tableau 2 : décompte des brevets par déposant personne morale
La différence entre les 2 tableaux permet de chiffrer les déposants personnes physiques

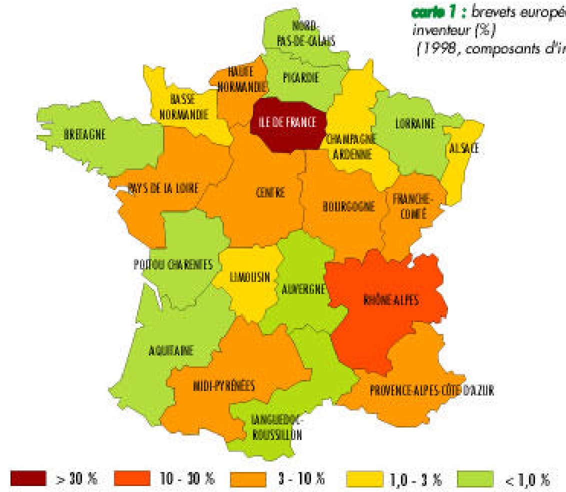
Tableau 3 : les premières régions d'invention des brevets correspondant aux déposants les plus actifs en 1998 dans le domaine " composants d'interconnexion et d'interface "

Déposants personnes morales	Régions déposants	Régions inventeurs		
		1ère région	2ème région	3ème région
FRAMATOME CONNECTORS INTERNATIONAL	Ile-de-France	Pays de la Loire	Centre	Ile-de-France
SCHNEIDER ELECTRIC SA	Ile-de-France	Rhône-Alpes	Bourgogne	Ile-de-France
ALCATEL	Ile-de-France	Ile-de-France	Franche-Comté	Centre
FRAMATOME	Ile-de-France	Pays de la Loire	Bretagne	Midi-Pyrénées
LEGRAND	Limousin	Limousin	Haute-Normandie	Pays de la Loire
GEC ALSTHOM ELECTROMECANIQUE SA	Ile-de-France	Rhône-Alpes	Ile-de-France	Midi-Pyrénées
POUYET SA	Ile-de-France	Rhône-Alpes	Ile-de-France	Rhône-Alpes
THOMSON-CSF	Ile-de-France	Ile-de-France		
ENTRELEC SA	Rhône-Alpes	Rhône-Alpes	Centre	
VALEO VISION	Ile-de-France	Ile-de-France	Midi-Pyrénées	Haute-Normandie
RADIALL	Ile-de-France	Rhône-Alpes	Ile-de-France	Centre
RAYCHEM PONTOISE SA	Ile-de-France	Ile-de-France	Picardie	
SYLEA	Ile-de-France	Ile-de-France		
données INPI et OEB, traitements OST				

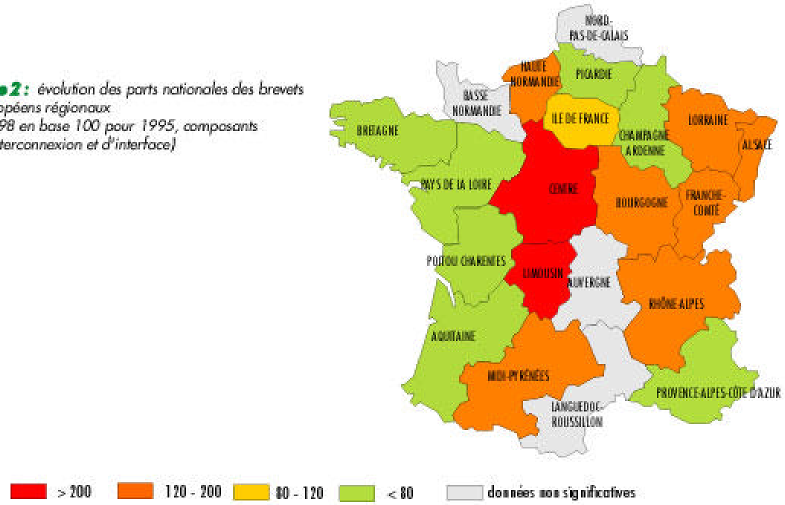
••• seule la répartition en régions inventeurs des déposants ayant déposé plus de 5 brevets est donnée.

••• nous n'indiquons que les 3 premières régions inventeurs de chaque déposant, pour les régions ayant au moins un brevet

carte 1 : *brevets européens régionaux en part nationale inventeur (%) (1998, composants d'interconnexion et d'interface)*



carte 2 : *évolution des parts nationales des brevets européens régionaux (1998 en base 100 pour 1995, composants d'interconnexion et d'interface)*



données INPI et OEB, traitements OST

2.2. Technological competencies: latest results for the year 1999

In the latest OST report (2002), we actualised the data. The following tables present the main results and particularly:

- the inter-regional distribution and specialisation index in technological competencies related to key-technologies 2005 (1995, 1999 and 1999 base 100 for the year 1995).
- the inter-regional distribution per large technological area of competencies related to key-technologies 2005 (1999).

Table 3. Inter-regional distribution and specialisation index in technological competencies related to key-technologies 2005 (1995, 1999 and 1999 base 100 for the year 1995)

	Inter-régional distribution (%)			Specialisation in key-technologies		
Regions	1995	1999	1999 base 100 = 1995	1995	1999	1999 base 100 = 1995
Ile-de-France	44,5	43,5	98	1,06	1,07	101
Champagne-Ardenne	1,1	0,9	82	0,88	0,80	90
Picardie	2,2	2,4	107	0,96	1,05	110
Haute-Normandie	1,6	2,3	140	0,92	0,94	102
Centre	2,4	2,7	110	0,75	0,75	100
Basse-Normandie	1,4	1,0	73	0,99	0,96	97
Bourgogne	1,8	1,8	101	0,86	0,83	97
Nord-Pas-de-Calais	2,5	2,2	87	1,00	0,98	97
Lorraine	2,3	2,5	109	1,08	1,03	95
Alsace	3,5	2,8	80	0,93	0,86	93
Franche-Comté	1,4	1,5	110	0,84	0,89	106
Pays-de-la-Loire	2,0	2,0	98	0,88	0,83	94
Bretagne	3,0	2,7	90	1,17	1,15	98
Poitou-Charentes	1,3	1,1	87	0,93	0,93	100
Aquitaine	2,5	2,2	90	1,10	1,03	93
Midi-Pyrénées	2,8	3,2	114	0,98	1,01	104
Limousin	0,5	0,3	62	0,93	0,71	77
Rhône-Alpes	14,3	16,0	111	0,91	0,95	105
Auvergne	1,6	1,7	110	1,21	1,17	96
Languedoc-Roussillon	1,5	1,5	104	0,97	0,91	94
Provence-Alpes-Côte d'Azur	5,6	5,4	97	1,05	1,01	96
France	100,0	100,0	100	1,00	1,00	100

données INPI et OEB, traitements OST *rapport OST-2002*

In 1999, Île-de-France has nearly 44% of the French European patents in the technological areas related to key-technologies 2005, but its national share decreased between 1995 and 1999. Rhône-Alpes represents 16% of the French technological competencies (+11% between 1995 and 1999).

The third region (Provence-Alpes-Côte d'Azur) only represents 5,4% of the French technological competencies.

The national shares of the other regions are less than 3,5%. Meanwhile, the evolution of Haute-Normandie is remarkable (+40%).

Table 4. Inter-regional distribution per large technological area of competencies

Regions	Inter-regional distribution (%) per large technological area related to key-technologies 2005 (1999)							
	Electronics-informatics	Instrumentation	Chemistry-materials	Biotechnology	Process	Transports and equipements	Civil engineering	All areas combined
Ile-de-France	53,7	44,4	29,7	46,3	39,1	42,5	30,2	43,5
Champagne-Ardenne	0,5	0,6	0,9	0,3	1,0	2,1	2,0	0,9
Picardie	1,1	0,7	5,3	0,8	4,3	3,6	3,9	2,4
Haute-Normandie	0,7	1,1	5,8	0,6	3,1	4,4	2,8	2,3
Centre	2,6	1,8	1,9	1,7	3,5	4,6	3,1	2,7
Basse-Normandie	1,0	1,2	0,4	0,5	1,1	1,6	1,0	1,0
Bourgogne	1,5	1,9	2,2	0,2	2,0	2,5	1,8	1,8
Nord-Pas-de-Calais	0,6	2,2	4,9	4,6	2,7	1,8	2,2	2,2
Lorraine	1,5	1,6	4,1	0,7	3,0	2,2	7,7	2,5
Alsace	1,2	1,7	5,0	8,6	2,7	2,4	5,1	2,8
Franche-Comté	1,2	1,5	0,5	0,0	1,4	3,2	3,3	1,5
Pays-de-la-Loire	1,4	1,7	0,9	1,2	3,2	2,7	4,2	2,0
Bretagne	4,3	2,4	1,1	3,1	2,2	1,5	1,9	2,7
Poitou-Charentes	0,7	1,1	0,5	0,4	1,1	3,4	1,1	1,1
Aquitaine	0,8	2,9	4,4	1,3	2,7	1,3	3,2	2,2
Midi-Pyrénées	3,4	3,9	1,9	3,6	2,4	3,1	2,9	3,2
Limousin	0,5	0,2	0,4	0,0	0,2	0,1	0,2	0,3
Rhône-Alpes	15,5	18,6	21,3	17,4	15,6	5,6	16,0	16,0
Auvergne	0,1	0,8	3,3	2,0	1,0	7,0	1,2	1,7
Languedoc-Roussillon	0,7	2,2	1,3	3,7	2,7	0,4	0,9	1,5
Provence-Alpes-Côte d'Azur	6,6	7,0	4,0	2,9	4,7	3,4	4,5	5,4
France	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

données INPI et OEB, traitements OST *rapport OST-2002*

related to key-technologies 2005 (1999)

The analysis per large areas shows that Île-de-France presented considerable competencies in electronics-informatics with 53,7% of the European patents. Rhône-Alpes is the second region with a national share close to 15%. Provence-Alpes-Côte d'Azur and Bretagne presented respectively 6,6% and 4,3% a national share higher than the national share all combined areas.

Provence-Alpes-Côte d'Azur and Midi-Pyrénées realise the best performance in the instrumentation area with a share close to 7% and 4%.

Rhône-Alpes has its main competencies in chemistry-materials with a share (21,3%) close to those of Île-de-France (29,7%).

Three other regions have competencies related to key-technologies 2005 in this area: Picardie (5,3%), Haute-Normandie (5,8%) and Alsace (5%).

In biotechnology, following the first two regions (Île-de-France with 46,3% and Rhône-Alpes with 17,4%), Alsace counts for 8,6%, and Nord-Pas-de-Calais represent 4,6% of the French competencies in the biotechnologies area.

In the process area, competencies are very concentrated in Île-de-France and Rhône-Alpes, but six other regions are sensibly active: Provence-Alpes-Côte d'Azur

(4,7%), Picardie (4,3%), Centre (3,5%), Pays-de-la-Loire (3,2%), Haute-Normandie (3,1%) and Lorraine (3%).

Transport-equipment is remarkable as regards the low national share of Rhône-Alpes (5,6%). In the same time, Auvergne (7%), Haute-Normandie, and Centre are around 4,5%.

Finally, in 1999, Lorraine is very active in civil engineering with a share close to 7,7%. The competencies in this area are not developed in Île-de-France (30,2%) as regards the other regions.

III. Perspectives of the analysis

In conclusion, it is important to note that in 1995, the French key-technology exercise was used to reorganise the funding system for technological development and reorientation funding.

In 2000, the French key-technology 2005 exercise and OST study were used by both French Ministry, and the Delegation for Spatial Planning and Regional Action[19] (DATAR) to encourage regional development.

This tool was used for the process of building and following of the latest "*Contrats de Plan Etat – Régions*" (hereafter CPER[20]), which is a 20 year old contractual relationships experience between the state and the regions.

[19] DATAR is an interministerial administration designed to insure the coherence of the ministers' spatial planning policies. At the service of the prime minister and available to the Ministry for civil service, state reform and spatial planning, the DATAR is a "mission administration", with a decisive prospective role. It is one of the preferential partners of the French regions, notably in the implementation and the follow-up of the Plan Contract between the State and the Regions, in the interface with Europe, but also in the implementation of policies promoting territorial economic development. These partnerships will be strengthened with the new decentralisation process which is being implemented in France (http://www.datar.gouv.fr)

[20] CPER ("*Contrats de plan Etat-région*") are agreements for a pluri-annual programming of the financing of priority actions concerning territorial development. France is traditionally a centralised country with a large role of "*préfets*" who are assisted by "*secrétariats généraux à l'action régionale*" (hereafter SGAR) in the regions, in charge of regional development and management of EU Structural Funds. The "*decentralisation*" laws (1982-83) enlarged local and regional authorities' competencies by giving an executive power to both presidents of regional councils and presidents of "departmental" authorities ("*conseils généraux*").

During the 1984-1988 period, the first generation of CPER is created and co-financed by the state and the local/regional authorities. With the European Community's reform of structural funds (in 1988), the French government decided to link CPER and community support frameworks through a kind of "contractually" oriented relationships.

The state and regions select together common coherent priorities in the economic, social, and cultural territorial development through a consultation and consensus-building process ("*concertation*"). Identification and selection of priorities come from a prior strategic and prospective exercise with a combination of 3 principles in order to allow both partners to agree on a set of priorities selected "scientifically" and "democratically". It is supposed that the state and regions are equal partners by "*contractualisation*" process between the two contracting parties for selecting common priorities and

The OST's approach constitutes a possible extension of the French technology foresight exercise, which is a necessary exercise, highly complex, but without the best methodology.

One of the most important functions of the concerned OST study is to provide for usable tools to profile scientific and technological competencies at the regional level and to develop attractiveness and cooperation strategies at the regional level (cooperation strategies when a region has strong technological competencies and other regions medium competencies, cooperation strategies when two regions have medium technological competencies…).

The OST's work has also been used and continues to be used by the local/regional administrations, as well as the French Economic observatory of Defence, and more generally by many institutional actors, who need a "*meso mapping*" of scientific and technological competencies at the French regional level[21].
The study can also be included in the discussion about regional technological development related to the problems of the localisation of scientific and technological competences (see Zitt et al. [1999; 2000][22]), and the "centres of excellence" localisation.

It finally constitutes an important input in the OST's indicators scoreboards and studies commanded by regional/local authorities to the OST.

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agreeing upon joint financing commitment. The state and the regions organise "*planning*" and not "*national plan*" with a new "*territorialisation*" approach being progressively elaborated. The objective is to go further than the "top-down" approach of the "*Délégation à l'Aménagement du Territoire et à l'Action Régionale*" (DATAR) of the 1960's.

[21] See Cadiou et Sigogneau [2002].

[22] Those works aim to establish typology of EU regions on science and technology criteria in order to study gross co-location of science and technology in the EU and "spill-over" potential. The S&T interactions are controlled by population and GDP.

Annex

List of 119 key-technologies

Technologies de l'Information et Communication
1 Microélectronique silicium
2 Micro technologies - Microsystèmes
3 Microélectronique III V (AsGa, InP)
4 Capteurs intelligents
5 Mémoires de masse
6 Composants optoélectroniques et photoniques
7 Composants d'interconnexion et d'interface
8 Capteurs de vision ou capteurs d'image
9 Écrans plats
10 Équipements et matériaux pour salles blanches, robotique
11 Batteries et gestion de la micro énergie
12 Objets communicants autonomes (Identifiants intelligents, Étiquettes)
13 Assistants digitaux portables
14 Technologies logicielles pour les systèmes temps réel ou contraint
15 Technologies logicielles de la langue et de la parole
16 Infrastructures pour réseaux dorsaux haut débit
17 Technologie de boucle locale
18 Technologies logicielles pour le transport de données
19 Réseau domestique numérique
20 Technologies logicielles pour la sécurité des réseaux
21 Intermédiation et intégration de services pour l'Internet du futur
22 Grands serveurs
23 Transmission temps réel de contenus multimédia
24 Technologies logicielles pour la gestion des données et du contenu
25 Systèmes auteurs pour création de contenu multimédia
26 Technologies logicielles de réalité virtuelle
27 Technologies logicielles de l'informatique distribuée
28 Génie logiciel
29 Technologies de spécification, de conception, de preuve, d'optimisation et de simulation de grands systèmes complexes
30 Mesures et tests de systèmes

Matériaux - Chimie
31 Alliages de polymères
32 Nano composites, et renforts nanométriques
33 Matériaux pour systèmes avancés (piézo-électriques, ferroélectriques et magnétiques)
34 Matériaux absorbants de chocs, de vibrations, de bruits, de chaleur
35 Matériaux pour procédés en milieux extrêmes (hautes températures, froid…)
36 Fibres textiles fonctionnelles
37 Catalyseurs
38 Ingénierie et traitement des surfaces
39 Procédés biotechnologiques et biomimétiques de synthèse de minéraux et polymères
40 Procédés de mise en œuvre et de formulation de la matière molle
41 Élaboration de composites à matrice organique
42 Surveillance intelligente de l'élaboration et de la mise en œuvre des matériaux
43 Évaluation non destructive de l'endommagement des matériaux et des assemblages
44 Fabrication en petites séries à partir de modèles numériques
45 Modélisation complète de la transformation des matériaux et intégration dans des bases de données
46 Modélisation moléculaire des polymères
47 Techniques de synthèses et de tests haut débit

Construction - Infrastructure - Habitat
48 Systèmes performants pour enveloppe de bâtiment
49 Techniques de diagnostic des structures
50 Technologies de déconstruction
51 Conception et mise en œuvre des ouvrages dans une logique de développement durable
52 Ingénierie concourante
53 Réalité virtuelle augmentée pour la conception architecturale et technique
54 Gestion de l'air dans les bâtiments
55 Réduction des bruits
56 Béton à performances optimisées
57 Matériaux composites pour les routes (les enrobés)
58 Technologies de travaux souterrains
59 Off shore grands fonds
60 Robotique mobile en milieu hostile

Environnement - Énergie
61 Stockage de l'énergie
62 Pile à combustible
63 Micro turbine
64 Éoliennes offshores
65 Photovoltaïque
66 Éclairage et visualisation à basse consommation
67 Supraconducteurs
68 Piégeage et stockage du CO2
69 Conditionnement / entreposage et stockage des déchets nucléaires à vie radioactive longue
70 Fluides frigorigènes à haute qualité environnementale
71 Stabilisation en vue du stockage et de l'utilisation éco compatibles des déchets ménagers
72 Recyclage de matériaux spécifiques
73 Élimination des métaux lourds dans les boues et les effluents
74 Filtration membranaire
75 Développement des techniques de diagnostic et de traitement des sols
76 Outils de gestion et d'évaluation des risques environnementaux et sanitaires

Technologies du Vivant - Santé - Agroalimentaire
77 Ingénierie des protéines
78 Transgénèse
79 Détection et analyse des risques pour l'environnement liés aux OGM
80 Thérapie génique
81 Clonage des animaux
82 Criblage de molécules actives
83 Greffe d'organe
84 Thérapie cellulaire
85 Organes bio artificiels
86 Imagerie médicale
87 Chirurgie assistée par ordinateur (GMCAO)
88 Miniaturisation des instruments de recherche médicale
89 Traçabilité
90 Marquage métabolique des aliments
91 Technologies " douces " pour la préservation de la qualité des aliments
92 Biocapteurs, biopuces

Transport - Aéronautique
93 Architecture électrique
94 Architecture électronique - informatique répartie et multiplexage
95 Compatibilité électromagnétique
96 Composants électroniques de moyenne puissance
97 Sûreté des systèmes embarqués et des infrastructures
98 Ergonomie de l'interface homme-machine
99 Amélioration des performances énergétiques d'ensemble des véhicules
100 Véhicules intelligents et communicants
101 Moteurs thermiques
102 Amélioration du coût et des performances des lanceurs spatiaux

Biens et services de consommation
103 Outils de personnalisation de la relation client
104 Agents intelligents
105 Offre de produits et de services de grande consommation à base de réalité virtuelle
106 Outils de santé à la disposition des consommateurs
107 Design sensoriel y compris la métrologie sensorielle
108 Méthodes de marketing liées à l'utilisation des TIC

Technologies et Méthodes de Conception - Gestion - Production
109 Systèmes d'organisation et gestion industrielle améliorés
110 Formalisation et gestion des règles métiers
111 Outils d'aide à la créativité
112 Représentation de la perception du consommateur
113 Simulation, modélisation du comportement humain (dans le poste de travail, face au produit…)
114 Multi représentation des objets virtuels / qualité de la représentation
115 Simulation numérique des procédés
116 Représentation et gestion des processus de l'usine numérique
117 Prototypage rapide
118 Supply Chain Management
119 Soutien Logistique Intégré

List of 24 scientific fields of competencies

01 : Biologie végétale et animale
botanique, biologie végétale
sciences des productions animales
sciences et techniques agro-alimentaires

02 : Biotechnologies
biocybernétique
biométhodes
biomatériaux
bioingénierie
biotechnologie et microbiologie applique
génie biomédical

03 : Chimie
chimie appliquée
chimie générale
chimie minérale et nucléaire
chimie organique
chimie physique
électrochimie

04 : Electronique
composants électroniques
génie électrique et électronique

05 : Génie chimique
énergie et carburants
génie chimique
génie chimique et thermodynamique
science des polymères
traitements de surface

06 : Génie génétique
embryologie
génétique, hérédité
systèmes reproducteurs

07 : Informatique
intelligence artificielle
sciences de l'information
informatique/applications
informatique/imagerie
informatique/théorie et systèmes

08 : Matériaux
cristallographie
matériaux/analyse
matériaux composites
métallurgie
science des matériaux
science des matériaux – céramiques

09 : Mathématiques et algorithmique
mathématiques appliquées
recherche opérationnelle
statistique et probabilités

10 : Sciences médicales et chirurgicales
transplantations
chirurgie
radiologie, médecine nucléaire
médecine interne générale
hématologie

11 : Biologie moléculaire et cellulaire
biochimie, biologie moléculaire
biophysique
biologie moléculaire et cellulaire
microbiologie

12 : Neurosciences
neurosciences
psychologie
sciences comportementales

13 : Optique et imagerie
optique
photographie, imagerie

14 : génie industriel
contrôle 2
génie industriel
ingénierie/systèmes

15 : pharmacie - pharmacologie
toxicologie
virologie
pharmacologie - pharmacie
immunologie
allergologie

16 : physiologie
anatomie, morphologie
nutrition, diététique
physiologie

17 : Physique appliquée
acoustique
instrumentation
physique appliquée

18 : Physico-chimie
physique des fluides et plasmas
physico-chimie
physique du solide

19 : Sciences et techniques de la terre
génie minier
géologie
géotechnique
génie pétrolier
autres géophysique-géochimie

20 : génie mécanique et de la construction
génie de la construction
mécanique
génie mécanique

21 : Sciences et techniques de l'environnement
technologies de l'environnement
écologie
sciences de l'environnement
océanographie
ressources en eau

22 : Science et technologie nucléaire
science - technologie nucléaires

23 : Télécommunications
télécommunications

24 : Génie aérospatial
génie aérospatial

List of 30 Technological areas of competencies

01 : Production et utilisation de l'énergie électrique
F21 : éclairage
H05B : éclairage électrique
H02J : production, conversion ou distribution de l'énergie électrique

02 : Composants d'interconnexion
H01R : connexions conductrices de l'électricité
H05K : circuits imprimes

03 : Stockage de l'énergie électrique
H01M : conversion directe de l'énergie chimique en énergie électrique (ex. batteries)
G05F : systèmes de régulation des variables électriques ou magnétiques

04 : Supraconducteurs
H01B, F : conducteurs, isolateurs, diélectriques, aimants, inductance avec supraconductivité

05 : Visualisation
G09G : dispositions ou circuits pour la commande de l'affichage utilisant des moyens statiques pour présenter une information variable
H01J : tubes ou lampes à décharge électrique

06 : Mémoires
G11B : enregistrement de l'information base sur un mouvement relatif entre le support d'enregistrement et le transducteur
G11C : mémoires statiques

07 : Composants électroniques
H04N : transmission d'images, haut-parleurs, microphones…., systèmes stéréophoniques
H01G, L : condensateurs, dispositifs a semi-conducteurs; dispositifs électriques à l'état solide non prévus ailleurs
H03 : circuits électroniques fondamentaux

08 : Télécommunications
H04B, H, J, L, M, Q : transmission, radiodiffusion, communication multiplex, communications secrètes; brouillage des communications, transmission d'information numérique, communications téléphoniques, sélection
H01P, Q : guides d'ondes; résonateurs, lignes, antennes

09 : Informatique
G06 : calcul; comptage
G10L : analyse ou synthèse de la parole; reconnaissance de la parole

10 : Optique
G02 : optique
H01S : dispositifs utilisant l'émission stimulée

11 : Analyse-mesure-contrôle
G01B, C, D, F, G, H, J, K, L, M, N, P, R, S, V, W : métrologie (sauf mesure des radiations)
G05B, D : systèmes de commande ou de régulation; éléments fonctionnels de tels systèmes; dispositifs de contrôle
G07 : dispositifs de Contrôle
G08B, G : systèmes de signalisation ou d'appel, systèmes de commande du trafic

12 : Ingénierie médicale
A61B, C, D, F, G, H, J, L, M, N : diagnostic; chirurgie; identification, technique dentaire, instruments, appareils, outillage ou méthodes de médecine vétérinaire, prothèses, moyens de transport ou accessoires pour malades, appareils de physiothérapie, récipients spécialement adaptes a des fins médicales ou pharmaceutiques, procèdes ou appareils pour stériliser des matériaux, dispositifs pour introduire des agents dans le corps ou les déposer sur celui-ci, électrothérapie…..

13 : Chimie macromoléculaire
C08B, F, G, H, j, K, L : composes macromoléculaires organiques

14 : Biotechnologies : méthodes et procédés de détection
C12Q : procédés de mesure, de recherche ou d'analyse faisant intervenir des enzymes ou des micro-organismes

15 : Biotechnologies : traitements et thérapeutiques
A01K67 : Elevage ou obtention d'animaux, non prévus ailleurs; Nouvelles races d'animaux
A61K38, 39, 48 : Préparations médicinales des peptides, des antigènes ou des anticorps, du matériel génétique, Thérapie génique
C07H19, 21 : Nucléosides, mono nucléotides, Acides nucléiques
C07K14 : type de peptides, Immunoglobulines, peptides hybrides
C12M, N, P, S : Appareillage pour l'enzymologie ou la microbiologie, Micro-organismes ou enzymes, techniques de mutation ou de génétique, Procédés de fermentation ou procédés utilisant des enzymes pour la synthèse d'un composé chimique, Procédés utilisant des enzymes ou des micro-organismes pour libérer un composé ou une composition préexistants

16 : Traitement des produits agricoles et alimentaires
A21D : traitement et conservation, de la farine ou de la pâte
A23B, C, D, F, G, J, K, L : aliments ou produits alimentaires et leur traitement

17 : Procédés techniques
B01 : procedes ou appareils physiques ou chimiques

18 : Traitements surface
B05C, D : appareillages et procédés pour l'application de liquides ou d'autres matériaux fluides aux surfaces
B32 : produits stratifies
C23 : revêtement de matériaux métalliques
C25 : procédés électrolytiques ou éléctrophorétiques

19 : Traitements des textiles
D01 : fibres ou fils naturels ou artificiels; filature
D02 : fils; finition mécanique des fils ou cordes; ourdissage ou dressage
D03 : tissageD06B, C, G, H, J, L, M, P, Q : traitement des textiles ou similaires

20 : Matériaux-métallurgie
C01 : chimie inorganique
C03C, B : composition chimique des verres
C04 : ciments; béton; pierre artificielle; céramiques; réfractaires
C21 : métallurgie du fer
C22 : métallurgie
B22 : fonderie; métallurgie des poudres métalliques
B29 : travail des matières plastiques

21 : Climatisation
F24F: conditionnement de l'air
F25B, C : réfrigération ou refroidissement; systèmes combines de chauffage et de réfrigération; systèmes a pompes a chaleur; fabrication ou emmagasinage de la glace

22 : Environnement-pollution
A62D ; moyens chimiques pour éteindre les incendies ou pour combattre les agents chimiques
C02 : traitement de l'eau, des eaux résiduaires, des eaux ou boues d'égout
B09C : regénération de sols pollues

23 : Environnement : traitement des déchets
B09B : élimination des déchets solides;
F23G,J : incinération des déchets, enlèvement ou traitement des produits ou des résidus de combustion; conduits
B03B : séparation des solides par utilisation de liquides

24 : Environnement : traitement du bruit
F01N : silencieux ou dispositifs d'échappement pour "machines" ou machines motrices en général; silencieux ou dispositifs d'échappement pour moteurs a combustion interne
F16F: amortisseurs, moyens pour amortir les vibrations

25 : Moteurs
F02 : moteurs a combustion

26 : Transports terrestres et équipements
B60 : véhicules en général

27 : Construction off-shore
B63 : navires ou autres engins flottants

28 : Spatial
B64G : astronautique; véhicules ou équipements a cet effet

29 : Techniques nucléaires
G01T : mesure des radiations nucléaires ou des rayons x
G21 : physique nucléaire; technique nucléaire
H05G, H : technique des rayons x et des plasmas

30 : BTP : infrastructures
E01 ; E02 ; E03 ; E04 ; E05 ; E06, C10C : construction de routes, bâtiment, hydraulique
E21 : forage du sol ou de la roche; exploitation minière

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