WP 1 – REVIEW AND ANALYSIS OF NATIONAL FORESIGHT

# D1.1FR – CASE STUDY

## FRANCE – TECHNOLOGIES CLÉS 2005

STATUS: PUBLIC

PARTNER RESPONSIBLE:
FZK-ITAS
Forschungszentrum Karlsruhe GmbH in der Helmholtz-Gemeinschaft,
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*The FISTERA network is supported by the European Community under the FP5 specific program for research, technological development and demonstration on a user-friendly information society (1998-2000).*

# WHAT IS FISTERA?

**FISTERA** is a Thematic Network on Foresight on Information Society Technologies in the European Research Area.

The **FISTERA** network is supported by the European Community under the FP5 specific program for research, technological development and demonstration on a user-friendly information society (1998-2002).

The aim of the FISTERA Thematic Network is bring together on a systematic and extended basis, actors and insights in national foresight exercises on IST in the Enlarged Europe.

Main objectives:

- Compare results of national foresight exercises and exchange visions on the future of IST
- Provide a new forum for interactive consensus building on future visions for IST
- Contribute to the European Research Area through benchmarking and community building, by providing a dynamic pan European platform on foresight on IST

In order to meet these three key objectives, FISTERA will:

- Review and analyse the national foresight exercise outcomes (a country synthesis report)
- Build aggregate pan European Technology trajectories (a roadmap of potential developments of key emerging technologies)
- Map the European IST actor space (an analysis of the EU IST actor space)
- Provide an IST Futures Forum (strategically selected scenario exercises that will look at wider aspects of applications of IST)
- Disseminate the results to a targeted audience by various means (a dynamic website at the address http://fistera.jrc.es, an e-mail alert service, publications, conference presentations, a "road-show" of workshops and a final conference)

**Network Membership:**
**Core partners** (coordinators, work package leaders):

- JRC-IPTS (Institute for Prospective Technological Studies), part of the European Commission's Joint Research Centre, Scientific Coordinator of the network.
- FZK - ITAS (Forschungszentrum Karlsruhe GmbH in der Helmholtz-Gemeinschaft, Institut für Technikfolgenabschätzung und Systemanalyse), Germany.
- TILAB (Telecom Italia Lab – Scenarios of the Future), Italy.
- ARC/sr (ARC Seibersdorf research GmbH, Division Systems Research Technology-Economy-Environment, Seibersdorf), Austria.
- PREST (Policy Research in Engineering, Science and Technology) of the University of Manchester, United Kingdom.
- GCI (GOPA - Cartermill International), Belgium, Administrative and Financial Co-ordinator.

The group of **Members**, which is expected to grow over the duration of the contract, currently includes the following organisations: TNO-STB (The Netherlands), Danish Teknologisk Institut (Denmark), TecnoCampusMataró (Spain), Observatório de Prospectiva da Engenharia e da Tecnologia-OPET (Portugal), ARC Fund (Bulgaria), IQSOFT (Hungary), Tubitak (Turkey), The Researchers' Association of Slovenia (Slovenia), NMRC, University College Cork (Ireland) and BRIE-Berkeley University (USA). In addition, McCaughan Associates (McCA) runs a group of High-level Experts to the Network Management Committee.

FISTERA Web site: http://fistera.jrc.es/

## Contents

## Summary

The second French Technologies Clés study ran from 1998-1999 with the report published in 2000. It was organised in 8 thematic panels involving about 12 experts per panel and 500 additional experts. The aim was to identify critical technologies and to benchmark the positions of France and Europe in global competition in addition to updating the former exercise. The time horizon was five years and methods included an Internet forum of experts in addition to the questionnaire survey and work in panels. The outcome was a list of 119 critical technologies

# 1 Background and Objectives

In France, programmes and planning are conducted to a relatively large extent by the government, i.e. by the Ministry of Industry (Ministère de l'Economie, des Finances et de l'Industrie ) and the Ministry of Higher Education and Research (Ministère de l'Enseignement Supérieur et de la Recherche, MESR). Research is also done by industry.

Public foresight activities experienced a revival in the 1990s (some important exercises had been done in the 60s and 70s):

- the first French Delphi survey on science and technology, a repetition of the 5th Japanese Delphi under the responsibility of the MESR, was launched in 1993; the study was not widely circulated
- the Ministry of Industry developed another type of foresight: studies with relatively short-term perspectives that can already be considered as specific statements of position in the national context
- in 1993-1994 a study of the critical 100 key technologies for French industry (Les 100 Technologies clés) was launched and the report published in 1995; five years later, in 1998-1999 a second study updated the report with progresses in some important aspects (Technologies clés 2005). The report was published in October 2000.

Whereas the first study laid emphasis on analysing supply and demand of technologies in France, the second study identified technologies potentially important for the future of Europe and for each of the 119 most critical technologies the relative strength for France and Europe was positioned versus world competition. In comparison to the first study a larger number of experts were mobilized to participate in the process.

# 2 Organisation of the Foresight Exercise

Both "Technologies Clés" exercises dealt with three main questions:

- which are the important technologies for French industry?
- what is the national (and European) leadership in these fields?
- where must the efforts be placed?

The time horizon was a maximum of 10 to 15 years with the aim of identifying technologies worth support in around 2005. The study aimed at crossing the autonomous dynamics of science and the technology needs expressed by the market. The method chosen was similar to that used in the 'German technologies at the Beginning of the 21st century' (Grupp 1994): Groups of 10 to 20 experts, representing the most influential actors of the French R&D system, dealt with either 'technology pushed' or 'market-pulled' technologies in order to provide a workable list of critical technologies for French industry. Then, each technology was to be described and assessed in a national context. The steering committee was set up by the Ministry.

# 3 Method and Procedure

In the *first* technologies clés study, the process consisted of 4 steps:

1. selection of 9 criteria for the 'importance' of a technology
2. identification of the technologies by using the 9 criteria. At the end of this stage, 136 technologies were selected

3. assessment of the French and European position for each technology
4. characterisation of the critical technologies in terms of distinctive capacities, attractiveness, and success conditions.

At the end of this stage, 105 technologies were labelled 'critical' for France, although the whole set of 136 is described in the report. For each, a short description and a ranking of the degree of the development, the relative scientific leadership and the industrial competitiveness of France and Europe are given.

The "Technologies Clés 2005" study proceeded in a very similar manner. This time, 150 experts, divided in 8 thematic sub-groups of about 12 members plus an 'interaction-quality' group, were involved in the process. They were selected from about 650 names; the remaining 500 were given the status of additional experts who evaluated and qualified the candidate technologies through mail questionnaires and through an Internet forum. The monitoring of the study was the task of a steering committee of 42 members (representatives from various ministerial departments, industry, public agencies and public research centres) which imposed a strict project management and constituted a sub-group to help finalize the selection of the key technologies.

The thematic sub-groups were:

1. Life Science, Health, Food
2. ICT
3. Energy – Environment
4. Materials – Chemicals
5. Building – Housing – Construction
6. Transportation – Aeronautics
7. Consumer Goods and Services
8. Technologies and Methods for Design, Manufacturing and Management

The process consisted of 4 steps:

1. identifying initial candidate technologies (600)
2. pre-selection according to attractiveness (grouped in 5 families with 4 subtitles each) for France and the EU (200)
3. judging the candidate technologies ("selected", "undecided", "rejected") by using the set of attractiveness-criteria (200)
4. selection of the most critical technologies according to the competitive position of French and European players (grouped in 1 family with 5 subtitles –'Scientific and technological Position'- and 1 with 7 subtitles –'Industrial and Market Position') (119).

119 key technologies were listed, qualified and described in detail. To qualify the 119 key technologies (items), listed in the 8 mentioned thematic groups, **a six column-grid** was constructed with the following items:

(1) Industries (Exemples de secteur d'application )
(2) Example of use (Exemple d'usage)
(3) Function fulfilled (Fonction remplie)
(4) Technology (Technologie)
(5) Critical technology points (Points technologiques critiques)
(6) Scientific domains concerned (Domaines scientifiques concernés)

Columns 1-3 dealt with the demand side:

(1) typical sectors of the economy, where the corresponding technology may be used
(2) some examples of usage for concrete applications
(3) the functional need fulfilled

Columns 4-6 characterized the technology:

(4) the technology operating as the solution to the functional need ('flag')
(5) the most critical aspects of the technology which may operate as a bottleneck, thus indicating where new development or breakthrough is needed
(6) typical scientific fields where research is needed to improve the technology

# 4 IST in the French Foresight Exercise

## 4.1 General findings on IST

The introduction to the report includes a section on "the new economy", pointing out the dangers of restriction of such a vision to the "net economy" while neglecting other aspects, such as education, organisation etc.

ICT (technologies de l'information et communication, TIC) are one of eight areas of technology used to categorise the key technologies. The report includes a description of the context in this domain. It underlines the need to integrate various key technologies in complex systems, the need to anticipate technological advances, emerging markets and to monitor R&D for promising developments as well as the development of means for the distribution of products and services.

The second "Technologies Clés" study in **France** focused mainly on identifying technologies important for the future of Europe, at the same time assessing the relative strengths of France and Europe in the global context. The study employed a questionnaire survey and an electronic forum on the internet with most work done in thematic sub-groups. Among the 8 thematic groups was one devoted to ICT (ITC in French). Certain of the items proposed and identified by other sub-groups had an IT component.

Within Information and Communication Technologies, **thirty key technologies** are listed:

01 Silicon micro electronics
02 Micro electronics – micro systems
03 Micro electronics based on semiconductors III-V
04. Intelligent sensors
05. Mass memories
06. Optoelectronic and photonic components
07. Components of interconnections and interface
08. Sensors for vision or image
09. Flat screens
10. Equipment and materials for clean rooms, robotics
11. Micro-batteries of high capacity
12. Autonomous communication objects (intelligent identifiers, electronic memory cards)
13. Portable digital assistants

14. Software technologies for systems for real or constrained time
15. Software technologies for language and speech
16. Infrastructure for high flow networks
17. Technologies for the local access to 'backbone' networks
18. Software technologies for the transport of data
19. Digital domestic net
20. Software technologies for net-security
21. Service intermediation and integration for the 'Internet of the Future'
22. Large servers
23. Real time transmission of multimedia contents
24. Software technologies for management of data and content
25. Author/assistant systems for the creation of multimedia contents
26. Software technologies for virtual reality
27. Software technologies for distributed data processing
28. Software development based on components
29. Engineering of large complex systems
30. Measurement and certification of systems

Characterisations of the 30 key technologies include a description of their relevance, an assessment of their technological maturity, an assessment of the stage of industrial application, assessments of the French and European positions with respect to scientific and technological research, an assessment of the French and European positions with respect to industrial and commercial application and examples of their use. Box 1 contains a sample characterisation for silicon microelectronics.

Silicon micro electronics contain a group of technology gathering processes and equipment for micro electronic CMOS Si<0.1µ, production systems of integrated circuits Si<0.1µ, tools for the conception of these integrated circuits and for the conception of chip systems such as the architectures and methods of testing equipment for integrated circuits < 0.1µ Research has to be done for the architectures (organisation of the transistors) permitting the primary functions (processors, report plan, decoders, bus). The very important market of integrated circuits (150 billion € in 1999) is increasing strongly (+15% p.a.)

Degree of development of this technology: growth

Degree of industrial and commercial applications: between the stadium of diffusion and generalisation

Position in the scientific and technical field: for France and Europe: strong

Position in the industrial and commercial field: France and Europe: stadium between moderate and strong

Examples of use: electronic components, micro processors, mobile personal assistants, terminals

**Box 1:** Sample description of key technology for Silicon Microelectronics

The introduction to the report on the exercise summarises that ICT consists of three main areas of activity: computer science, telecommunications and audiovisual technology. Countries only using such technologies will profit to a lesser extent from their benefits. France has a leading global role in telecommunications, information and telecommunications services. An increase in competition in these areas is expected.

ICTs are omnipresent, i.e. an "underpinning" or "key" technology. ICTs enable organisational innovations, which are at the root of progress in other areas of science and technology. In contrast, the life sciences, which could have a similar role, are experiencing difficulties with their introduction and application.

## 4.2 Analysis of National Strengths and Weaknesses

There was no separate analysis of strengths, weaknesses, opportunities and threats in the "Technologie Clés" study, but the entire project was targeted at assessing the relative strengths of France and Europe in selected fields of technology. This assessment was, however, restricted entirely to the technologies identified by its working groups.

## 4.3 IST Visions

The report contained a handful of isolated statements on the future role and shape of IST in society, starting with a warning against vision of "new economy" restricted to Internet. IST were regarded as a powerful tool for human creativity

Internet was seen as providing immense opportunity for coordination of economic activity and division of labour based on knowledge.

New forms of cooperation were seen as likely to contribute to an acceleration of technological progress, especially in IT. Firms, public institutions and infrastructure would be faced with a need to adjust their policies

# 5 Other Important Results of French Foresight

The "Technologies Clés" study analysed main consumer expectations for the year 2000, sometimes comparing French consumers with those elsewhere. The main results of this analysis can be summarised as follows:

- Consumers seek more complex, individualised products and services. They wish to have the permanent opportunity for contact with others. This applies particularly to the elderly and young people.
- Products need not necessarily be based on the latest innovations. If a consumer does consider buying an innovative product, he or she would like reassurance, for instance from a friend who already has it, or the possibility to try the product out. Products should be user friendly with attention given to the interface.
- There is consumer demand for product safety. Products should ideally comply with high hygienic standards and be produced safely and securely according to existing standards. Products are increasingly bought if they bear quality labels.
- There is also increasing demand for products complying with ecological standards, such as natural products or those that can be recycled. Preference is increasingly given to producers who do not pollute the environment and who manufacture "clean" products.

France and Europe are ranked as being in very similar situations with respect to research and industrial and commercial exploitation. In both cases, the position of research is superior to that of industrial and commercial use, which indicates need for an improvement in the links between these two sectors.

The project steering committee thus recommends improvement of cooperation between public research and industry, but also points out a need in some areas of technology for more coop

eration between customers and producers, companies, regional authorities and professional associations. The committee identifies a need for the creation of networks of actors and for a common dialogue. Support for technology projects by the Secrétariat d'Etat à l'Industrie is provided on the condition that a strategic partnership is set up for the purpose.

The steering committee also recommends giving preference to those technologies of more fundamental importance having potential for application in several areas, examples being sensors or databases.

The steering committee underlines the importance of so-called organisational and accompanying technologies, urges for further studies of the "Technologies Clés" type and for research on factors contributing to a cohesively organised system of innovation. In the European dimension, the steering committee mentions the framework programmes for research and development, but also underlines the need for common European standards and "leaner" legislation with fewer regulatory barriers. It also sees a need to upgrade the cultural value of science and technology, and strategies for legal decision-making should be fine-tuned for technological demands.

The study had a great impact, not at least because of the Ministry of Industry which declared the further industrial research subsidies programme as being oriented along the grid of the '100 key technologies'.

# 6 Literature

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France. In: R. Barré (OST), P. Ormerod (CEST) (eds.): Monitoring Foresight Activities. Appendix: Screening the foresight exercises undertaken in 12 countries. Deepening of foresight exercises having taken place in 6 countries. http://esto.jrc.es/docs/foresight2.pdf

**CM International 2000**
Technologies clés 2005. Rapport Final. Paris, Secrétariat d'Etat à l'Industrie

**Durand, T. 2002**
Selecting TechnologieS&Themes in "Technologies Clés" 2005. Presentation at Workshop "Participatory Priority Setting for Research and Innovation Policy – Concepts, Tools and Implementation in Foresight Processes". Berlin, 13 – 14 December 2002

**Grupp, H. 1994**
Technology at the beginning of the 21st century. Technology Analysis and Strategic Management 6(4): 379 - 408

# Annex 1: Tabular Overview

| Foresight effort Technologies Clés 2005 1998-2000/France | | |
|---|---|---|
| **Categories, Criteria & Questions** | **Answers** | **Comments** |
| Project promoter / initiator | – Ministry of Economics, Finance and Industry, Secrétariat d'Etat à l'Industrie | |
| Agency or organization responsible for the foresight activity | – CM International/Cité des Sciences/Crédoc/Innovation 128/MCN Conseil/Central Cast-Net2One | |
| Scope / areas covered | – 119 key technologies, subdivided into 8 "domains" | |
| Time horizon | – 5 years (up to 2005) | |
| Societal dimension | – e.g. through introductory chapter outlining customer needs | |
| European dimension | – explicit through comparison of French position to European and global | |
| Major explicit objectives | – identification of key or critical technologies | |
| Second order objectives and indirect effects | – report also recommends creation of networks to strengthen ties between public research, industry, regional authorities etc., public funding now partially dependent on formation of strategic partnerships | |
| Impact | – Ministry of Industry declared further industrial research subsidies programme as being oriented along the grid of the '100 key technologies'. | |
| Target groups | – mainly administration, to lesser extent industry | |
| Participation | – 150 experts in panels, a further 500 "additional" experts evaluating | |
| Major Characteristics | – mainly survey results preceded by analysis of situation, list of 119 key technologies with uniform description | |
| Methodology | – questionnaire survey and Internet form prepared by experts in 8 thematic subgroups, whose work including formulating statements for the questionnaire. | |
| In which way have IST been included and treated in the FS exercise? | – one thematic sub-group devoted to ICT (TIC). 30 items characterised as key technologies, chapter in book on "new economy" | |
| Strengths/opportunities weaknesses/threats identified in IST | – France strong in telecommunications and related services, need to be active in field not only as user | |
| Dissemination | – report published as book in 2000, also available on web. | |