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FISTERA - THEMATIC NETWORK ON FORESIGHT ON INFORMATION SOCIETY TECHNOLOGIES IN THE EUROPEAN RESEARCH AREA

WP 1 – REVIEW AND ANALYSIS OF NATIONAL FORESIGHT

D1.1 – FIRST REPORT ON REVIEW AND ANALYSIS OF NATIONAL FORESIGHT

REPORT ON FINDINGS ON IST FROM EIGHT SELECTED NATIONAL FORESIGHT EXERCISES

STATUS: PUBLIC

PARTNER RESPONSIBLE:
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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/

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Executive Summary

This report covers the results of the first phase of workpackage 1 (WP1) of the FISTERA network project. It contains a review and analysis of selected national foresight exercises focusing on insights and outcomes with respect to just a single area of technology, namely Information Society Technologies (IST). The major criteria for the selection of the Foresight cases were a) to cover a broad spectrum of different exercises and b) to concentrate on recently completed foresight exercises. As a result, national foresight exercises from Austria, the Czech Republic, France, Germany, Hungary, Spain, Sweden, and the United Kingdom were chosen. In this phase, regional foresight studies, studies conducted within industry, and studies from outside the EU25+ were deliberately omitted. A major benefit of the current exercise is the aggregation of information on IST-Foresight derived from the studies chosen, its systematisation and its availability as a public source of information.

The selected findings of the present analysis summarised here refer to (1) the general level, (2) challenges of IST-foresight, and (3) lessons for European level IST-Foresight.

(1) With the exception of Sweden, the national government commissioned the foresight study in each country. The range of methods varied from panel discussions and brainstorming to quite sophisticated multi-method exercises. As general trend, electronic means of communication are increasingly used to involve more people and to broaden participation during the exercise proper and afterwards. We also observe a trend that societal problems are more present in the minds of all foresight makers than in previous times. Characteristic constraints include a lack of time for the entire exercise or for certain of its elements, for information exchange between panels, and for adequate integration of different results. In addition essential Foresight ingredients like SWOT analyses, construction of future visions, and development of alternative options are often lacking or not present in the final report. The influence of the prescribed time horizon (between 5 and 30 years) on statements given remains still very unclear. Obviously the danger of just reproducing "Zeitgeist" statements is real, e.g. the special importance given to "electronic commerce" during the e-economy boom. Maybe because of doubts with respect to the long-term reliability of foresight statements, most studies underline the benefits of foresight in social terms, such as creating networks and raising awareness of the future

(2) Information and Communication Technologies (ICT) were treated as a separate area in all but one of the studies. IST played a role in many panels devoted to areas of technology other than information and communication technologies. In some studies they assumed the role of "underpinning" or key technologies. The major caveats for IST foresight to be taken into account are:

- Findings on IST tend to be scattered across the reports on each foresight study rather than concentrated in one place requiring a special effort to integrate the results of different panels etc.
- Major shortcomings of existing foresight studies concern the technology itself. It is obviously not a simple task for stakeholders to envisage applications for a technology about which little is known other than that it will be important.
- Research at the cutting edge of IST was seldom addressed due to the very application-oriented nature of most foresight studies, implying that special effort is needed to keep application orientation without loosing sight of cutting edge research.

- Due to the very dynamic nature of IST, it is very difficult for participants in foresight exercises to avoid falling victim to "Zeitgeist". As a result, the recommendations and findings are oriented mainly towards short-term policies. Zeitgeist" and the problem of "time-horizon" have to be methodologically controlled in rapidly changing fields, and thus pose a methodological challenge to foresight.
- Another problem of most studies is their failure to truly investigate alternative developments or the possibility of unexpected events ("wild cards"), such as unexpected technological breakthroughs, disrupters or technology related catastrophes.
- National visions concerning IST are underdeveloped in about half of the studies, due to their concern with "catching up" or "keeping touch" with global competition. More information is required on the setting, context and actual work of the foresight studies to provide greater insight into the role of IST in national visions for the future.

(3) From the review of IST-Foresight within national foresight exercises suggestions have been derived for foresight efforts requiring European cooperation to be successful.

- The European dimension is most clearly present in SWOT analyses as part of the national foresight exercises, although usually not very systematically. A task of EU level foresight could be a EU-level SWOT analysis. This dimension has already been recognized by FISTERA in its aim to map areas of particular scientific expertise and potential areas for collaboration.
- An option for European level foresight is a uniform exercise of the "Technologie Clés" type across all or several countries. This would include assessments of the relative positions of each country and Europe at a global scale for individual technologies or applications.
- Another task for European foresight studies could be to explore applications of "cutting edge" technologies envisaged by various actors within predetermined time-frames.
- A very helpful feature of the Swedish study was the "technology hindsight" study, which can contribute to improving the techniques used for forecasting technologies important in the future. Its subject were mainly technologies which had so far failed to fulfil their early promise, but it would also be useful to extend the approach to such technologies whose success (!) had not been predicted, the most recent examples being the Internet and GSM mobile telephony.

1 Introduction

The task of workpackage 1 of the FISTERA network project is to construct an IST sector specific analysis for an enlarged Europe (EU 25+) taking into account national Foresight exercises, and building upon existing general comparisons of foresight studies. Differences between foresight studies in different countries will be explained with the aim of drawing conclusions on IST developments and IST-foresight requirements at the European level. A major aim of the workpackage is to provide a basis for other FISTERA activities in the subsequent workpackages 2 to 4.

A novel aspect of FISTERA and the work done in workpackage 1 is its focus on a single area of technology, namely Information Society Technologies. The intention of the workpackage is eventually to provide a concise overview of IST aspects of recent foresight studies at the national level in European Countries, the United States, and Pacific Rim countries with a view on identifying European IST priorities. As far as possible and relevant, information will also be provided on regional and industrial foresight activities and other foresight-like activities, such as those related to the eEurope and eEurope+ initiatives.

This report covers the results of the first phase of work done on workpackage 1 (WP1). It contains a review and analysis of selected national foresight exercise outcomes. The document has been prepared by the workpackage leader, the Institute for Technology Assessment of Karlsruhe Research Centre (FZK-ITAS).

In the first phase of FISTERA, analysis was confined to a first selection of national studies. In most cases, the studies had not been read beforehand, so that the quality of the study or secondary information on the study from outsiders or participants did not play any role in the selection process. The major criterion for the initial selection of the Foresight cases was the coverage of a broad spectrum of exercises of different types. An additional criterion was their recentness: studies should have been completed in or after 2000. In some cases studies completed slightly before this deadline have been included if they are the only study in that country or if they were selected to represent a certain type of study, e.g. the “social Delphi”. In view of their importance for countries of the type, both studies completed in accession countries have been included.

The sample selected for the first round of FISTERA consists of:

- two accession countries: Czech Republic (2001-2002), Hungary (1997-1999, although diffusion activities have continued up to the present), which are the first two accession countries to have completed foresight studies,
- two countries using advanced Delphi techniques: Austria (1996-98), Spain (1998-2001),
- three countries with examples of socially-oriented Foresight: UK (2nd cycle, 1999-2002), Sweden (1998-2000), Germany (2001-2002),
- one advanced “critical technology” study: France (1998-2000).

This synthesis report containing results of analysis during the first six months of work on FISTERA is structured as follows: In chapter 2 the main findings across the eight studies are synthesised. Common features and national differences are pointed out, complemented by comparative statistics. The last section in this chapter is on the question to what extent the European dimension has been taken into account in the various national studies. Chapter 3 is spe

cifically about IST as addressed in the national foresight exercises. It is dealt with here, country by country, with the results of the thematic ICT panels and findings on ICT in the rest of the exercise. Next, chapter 4 summarizes the main ICT related findings across the eight studies. We distinguish findings on technology, on application areas, and on "cross-cutting" issues. A special ICT SWOT section, and a section on ICT visions follow. The final chapter 5 draws some conclusions relevant for future work within workpackage 1, and for FISTERA as such. The eight case studies are contained in the annexes to this report. The first annex consists of a table for each foresight study providing information for a set of common dimensions. The second annex contains the case studies, starting each presentation with background and aims of the exercise, followed by the organisation of the exercise, the methods and procedures applied, most important findings with respect to IST, and finally relevant results worth highlighting.

What's next?

The major national studies not included in this first phase will be described and analysed in subsequent work on the project. Table 1 (below) contains details of all national-level foresight studies known to FISTERA at the outset of the project.

Country	Recent Foresight exercises	Remarks
Current EU Member States		
Austria	**Delphi Austria 1996 - 1998**	2 Delphi-like studies on mobile communications and the new economy (see chapter 4)
Belgium	Federal Prospective Project	still ongoing/
Denmark	Foresight program 2001	
Finland	Parliamentary committee of the Future	semi-permanent activity for parliament
France	**Technologies Clés 2005,**	previous exercises include "Technologies Clés 2000) and a mini-Delphi
Germany	**Futur 2001 - 2002**	previous work includes Delphis 1993, 1996-98, Mini-Delphi 1994, Knowledge Delphi, Education Delphi
Greece	Ongoing	ongoing, launched 2001, source IPTS
Italy	Second Foresight ongoing	first study 1993 - 1995 on national priorities for industrial research
Netherlands	Technology radar 1998 Foresight committee "Knowledge for the Networking Economy"	
Portugal	Technology foresight "Engineering and Technology" 2000-2020	completed
Spain	**3 waves completed 1998-2001**	OPTI created as institution for coordination of foresight
Sweden	Second foresight exercise launched in December 2002	**technology foresight w. 8 sectoral panels** , report "The Foresighted Society",
United Kingdom	Third UK Foresight Cycle 2002 -	First UK Foresight Cycle **Second UK Foresight Cycle 1999 - 2002**

EU Candidate Countries		
Bulgaria		ongoing
Cyprus	Pilots on agriculture (eForesee Project)	ongoing
Czech Republic	**"Technology Foresight 2002"**	
Estonia	IST Foresight in Estonia (eForesee)	ongoing
Hungary	**Foresight program 1997 -1999**	completed
Malta	Pilots on learning and training services, biotech. + one to be determined. (Part of eForesee)	ongoing
Poland	Pilot areas being investigated at national level	information received at "Futur" conference, December 2002
Turkey	Vision 2023, with scenarios, Delphi, panels	ongoing
Other Countries		
Argentina	National, part of UNIDO initative	
Australia	ASTEC 1996	completed
Brazil	Panel/scenario for sectors in cooperation with UNIDO	ongoing
China	National Delphi study, supported by Ministry of Science and Technology	2000
Japan	8th Technology Foresight about to be launched	7 completed
Korea	National Technology Roadmap, time horizon 10 years	ongoing, 2 Delphi studies completed
Malaysia	Part of APEC	
New Zealand	Foresight project by Min. of Research, Science and Technology	completed
Peru	National study, part of UNIDO initiative	on-line foresight w. questionnaire survey
South Africa	National Research and Technology Foresight project (NRFT) including SWOT analysis, scenarios	completed in 1998
Uruguay	Programa Nacional de Prospectiva Tecnológica Uruguay 2015 with UNIDO	
Venezuela	Programme launched in 2000, part of UNIDO Latin America and Caribbean Technology Foresight Initiative	
USA	Several studies, including critical technologies (Rand), Delphi on Emerging technologies (G.Washington University)	overview in NISTEP 2001
International Organisations		
EU	Futures, Enlargement Futures	completed/ongoing (enlargement.)
APEC	Multi-economy foresight Thematic studies	ongoing
OECD	The OECD International Futures Programme consisting of 4 elements	

Table 1: Major Foresight exercises throughout the World (status: March 2003). Studies covered in this report are marked in bold type

There are also ongoing activities in several other countries, but too little is currently known about these to warrant their inclusion in the table. This will be updated during the course of the project. Every effort will be made to provide information on further countries, in particular the other accession countries.

Synthesis report and case studies

It is important to keep in mind that apart from the present synthesis report the case studies are being made available one by one on the Internet. They are designed as work in progress to be refined over time as additional information on various aspects is provided by local experts, members of the FISTERA network and others. The case studies are available from the FISTERA website at http://fistera.jrc.es. Readers are kindly invited to send comments, criticism and amendments related to these case studies, which will be updated continuously based on new information and any comments forthcoming.

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2 Results of the Analysis of Foresight Studies

2.1 Main Findings

This section contains a summary of the main findings of the analysis of the national foresight studies. The issues addressed here include approach, organisation, method and goals of the various foresight studies, the time horizon, difficulties for participants in escaping from short-termism and in creating visions, special aspects of IST. Among the findings are:

- *The exercises selected for review represent a cross-section of recent European foresight studies with respect to client, aim and approach*.

With the exception of Sweden, the national government has commissioned the foresight study in each country. In most cases, the results of the foresight studies were aimed mainly at science and technology decision-makers in or close to government with the Czech study, in the one extreme, focused narrowly on the production of a draft National Research Programme. In the other extreme, Spanish foresight was focused firmly on industry, although it was being funded by ministries. In some cases, focus had shifted, usually from aiming primarily to identify promising technologies or research areas, to the creation of networks of actors involved in the development of science and technology.

The range of methods varied from panel discussions and brain-storming with fairly modest-scale involvement of actors from outside the panels, to quite sophisticated multi-method exercises including such elements as Delphi surveys, scenario-building and web discussions.

Four of the studies, the Austrian, Czech, Hungarian and Swedish exercises, were the first endeavours of their kind in the country concerned. The Swedish study has been followed by a second started recently, but in the three other countries nothing definite has yet been decided on follow-up activities at a similar scale, although the final reports of the studies invariably contain a recommendation for further foresight.

The French study is the second of its kind in that country and there have been other foresight-like activities in the past, while in Germany there have been foresight activities of a different kind to that reported here, such as two major Delphi studies closely modelled on the Japanese example. UK foresight has been organised as a programme at science ministry level and has up to now consisted of three distinct phases. In Spain, OPTI has been created as a specialised institution to coordinate foresight activities with responsibility for sectoral foresights distributed among research organisations close to various branches of industry.

- *Of the eight exercises reviewed, two can not be classified as fully-fledged Foresight, namely the French and the Czech exercise, because of a lack of broad participation.*

In fact, in the ESTO review of national foresight exercises (ESTO 2001, p. 66) Rémi Barré argues that “Technologies Clés 2005” is not a genuine foresight study, since it fails to meet three criteria: time horizon, interaction among a broad range of actors and the level of elaboration of the objects being debated.

There are doubts that the time horizon selected for studies plays a major role. This issue is dealt with in a comment on the next page. Participation in both France and the Czech Republic was restricted mainly to experts, although in the case of the French “Technologies Clés”, there was an opportunity to discuss on an Internet web space. Early foresight exercises of the Delphi

survey type did not usually include participation beyond a circle of experts or elaborate beyond a list of items, so that these studies would have been regarded as foresights without hesitation in the past.

- *There is no single "best" method or "set of methods" for foresight. The suitability of methods depends on the goals of the study and the resources available.*

If the goal of the exercise is to identify technologies with great promise for the future but as yet not mature for application, greater effort should be devoted to involving experts than lay people. If the goal is to develop ideas for the application of technology through the creation of networks of stakeholders, participatory methods are essential. If a study consists of several panels considering the same technology or of separate elements, such as surveys, workshops or scenario building, it is essential to foresee adequate resources to ensure mutual consideration of results in other elements' work.

- *We may also observe that societal problems are more present in the minds of all foresight makers than years before. This is not only visible in the advanced societal foresights.*

Even in a country like France, ostensibly attempting to define "key technologies", the items submitted for ranking had a distinct functional dimension: "By essence, technology foresight is bound to be a dual exercise, both technology and demand led: technology and functional need are two sides of the same coin" (Durand 2002, p.6). The majority of items included in various Delphi surveys: "were actually not technologies but functional needs" (ibid.).

A similar finding was reported with respect to the items formulated for the Delphi survey in the Hungarian foresight programme, whose panels were composed mainly of persons of technological inclination.

In the Czech Republic, the panel dealing with IST was on the "information society" rather than information technology, again providing evidence of the social orientation of foresight.

- *It is not really clear if the time horizon selected for the studies, which varied between 5 and 30 years with some studies deliberately setting the time horizon for information technologies shorter, had any impact on the thinking of participants. This could be due to difficulties for participants in truly "thinking forward" more than a few years. It is difficult to escape from "Zeitgeist*".

The question of the time horizon is sometimes regarded as a criterion to decide whether an activity qualifies as genuine foresight as not. The short time horizon of a mere 5 years was a reason for an ESTO review to question the status of the French "Technologies Clés 2005" as a foresight study (ESTO 2001, p. 66).

Most other studies set their targets on longer time horizons, usually between 15 and 25 years (see annex 1). The dynamic nature of IST was acknowledged in individual cases, by setting a shorter time horizon for panels concerned with IST. However, asking participants to think decades into the future is without doubt a demanding challenge, which has probably not been met in foresight up to now. In its review of past forward-thinking studies ("Technology Hindsight"), the Swedish study identifies the importance of "Zeitgeist" - the influence of the spirit of the times. The impact of this factor is the tendency to assume that today's problems and technologies will continue to play a similar role in the future and simply to extrapolate the current situation. A result is perhaps a lack of "visionary" concepts in most studies.

An example of the influence of "Zeitgeist" are the energies devoted in some studies to electronic commerce, which was high on the agenda of investors and policy makers at the time. For instance, the second UK foresight programme included a retail e-commerce task force, e-commerce was also a major topic of the retail and consumer services panel, and there was a retail logistics task force which produced a report topically titled "@Your Home". To cap it all, the chairperson of one of the task forces introduces a report with the words "Not another report on e-commerce…" In contrast, GRID computing, which is currently a priority in many countries is only mentioned in few reports.

There have been criticisms that the results of foresight studies tend to be "bland" or simply reinforce the "mainstream", but on the other hand it has also been said that the UK foresight programme has encouraged the research councils to take greater risks (Wood 2002).

- *More and more electronic means of communication are used to get more people involved and to broaden participation during the exercise proper and afterwards***.**

Several exercises have used the web as a vehicle to submit draft reports to broad discussion. Something which has not yet been sufficiently examined is whether the use of electronic communications biases participation in one way or the other. Along with workshops, web discussion was a very major element in the German "Futur" study.

Electronic means are also an important vehicle for the dissemination of the results of the foresight exercises. They are effective means of making reports readily available to a broad audience whose attention they might otherwise have escaped. Another important effect might be learning from experience of others for countries or institutions embarking on their own foresight studies. At least web publication might help foresight beginners select the models which they feel are most relevant for their own endeavours and thus help them in the selection of foreign advisors.

- *A complaint about several of the foresight studies was the "lack of time and resources", either for the entire exercise or for certain of its elements, such as a Delphi study or the use of scenarios.*

Virtually all of the foresight studies were organised in parallel panels and produced a final synthesis report. Here, it was sometimes pointed out that the final outcome would have benefited if there had been some mutual interchange between the panels to harmonise their work in fields of overlapping interest. In other cases, the time available was too short to adequately integrate such elements as Delphi surveys (Hungary, UK first foresight cycle) or scenarios (Hungary, Sweden). In the first UK cycle, the preparation of the Delphi survey was felt to have been inadequate. In contrast, much time is usually devoted to networking and dissemination of reports to enable feedback from stakeholders. Over all, the discussion/feedback element seems to have been the most successful component of most foresight exercises.

- *Information Society Technologies (IST) or information and communication technologies (ICT) were treated as a separate area in all but one of the studies. IST played a role in many panels devoted to areas of technology other than information and communication technologies. In some studies they assumed the role of "underpinning" or key technologies. Findings on IST tend to be scattered across the reports on each foresight study rather than concentrated in one place*.

The exception was Austria, which did not group IST under a separate heading since the organisers of the foresight study felt that Austria would not play a major role in this area and preparatory studies had revealed that IST were not a top priority in the results of most European Delphi studies. Delphi Austria has since been criticised for this omission. A National Plan on R&D subsequently developed singles the Austrian ICT sector out as a "promising" field and there have subsequently been two "foresight"-like activities (Knoll et al. 1998) on mobile communications and the new economy (mafos, 2001). It has been suggested that the Delphi study was focused mainly on identifying fields where Austria could play a "leading role" while it might have been more useful to look at those which could be important, for instance, in creating jobs.

In all other cases, IST or ICT were the subject of at least one main panel and frequently played a major role in other panels. However, with the possible exception of the Swedish foresight study, the links between the panels were weak and no attempt was made, even by steering committees, to summarise all results on IST/ICT. This may again be indicative of lack of time and resources for the exercises.

- *More information is required on the setting, context and actual work of the foresight studies to provide greater insight into the role of IST in national visions for the future.*

While virtually all final reports on the studies claim that an analysis of strengths, weaknesses, opportunities and threats (SWOT) was an important element of the studies' work, the reports themselves contain little explicit reference to the results of such analyses, again with exceptions. The reports also contain little on the visions of the emerging information society guiding the activities on IST. It is possible that there are in fact tacit, shared assumptions amounting to such visions in the individual countries and that these are documented more explicitly elsewhere, e.g. in national e-Society initiatives, such as the Swedish "Information Society for All"(2000).

This underlines the importance of the role of FISTERA network members and additional national experts in proving the information required to come to a more balanced assessment of these factors than from the final reports of the foresight exercises.

- *Most studies underline the benefits of foresight, for instance in creating networks and awareness of the future, and contain a recommendation for the continuation of activities in this field. Even so, it is not certain if there will be more foresight in each case. Impetus might come from the European level.*

In Spain and the United Kingdom, bodies had been set up especially to oversee national level foresight. In the case of the UK there are regular reviews (consultations involving many stakeholders) which can result in a redirection of the programme. In Spain, each foresight study is contracted to an institution close to an industrial branch. It is still too early to judge if there will be a continuation of foresight activities in the Czech Republic, Germany or Hungary, since the project is either too recent (CR, Germany) or still at the discussion/diffusion phase (Hungary). In Sweden, a second project was launched at the end of 2002, while in Austria the Delphi study seems to have triggered special studies by industry, for instance on mobile telephony, to close gaps in the national study. At present, there seem to be no plans for a new national-level study in Austria.

2.2 Common Features and National Differences

2.2.1 Statistical Data

The data in this section is mainly on public spending on research and development and on the information technology sector. It is included to provide the basis for a comparison of the countries included in the first sample within the broader context of the EU.

Data from Eurostat and the OECD reveal the expected differences in terms of Gross Domestic Product (GDP), Gross Domestic Expenditure on Research and Development (GERD), and Government budget appropriation on R & D (GBAORD), the latter two being indicators for spending on research and development. Possibly surprising is the relatively equal purchasing power per capita in the current EU countries. The high GERD of Sweden and the relatively high one of the Czech Republic are also interesting. Looking at some IST-specific indicators like ICT market value, the relatively high ratio of the two accession countries is worth highlighting, as is the relatively weak position of Spain.

Sweden and the United Kingdom are the leaders in terms of ICT market value, with Germany and Ireland, given the latter's reputation as the "Celtic tiger" and the former's standing as an export-oriented economy, surprisingly both below EU average.

In terms of Internet access, the two accession countries are not unexpectedly lagging behind the EU 15 countries, and France and Spain are also below EU average. In keeping with its claim to being the most "e-ready" society in the world, Sweden is the European leader in terms of home and business Internet access.

It is to be expected that the situation in each country in terms of importance of the IT sector for its economy and in terms of access to the Internet will play a role in determining the outcome of foresight studies. Even if the country no longer is able to play a major part in the IT industry, the application of IT is usually essential to preserve the global competitiveness of industry.

Given the variety of cultural factors and skill patterns from one European country to the next, there is also a need to adapt IT to the needs of local users, be it with respect to language, or be it with respect to predominant forms of organisation and division of labour. This indicates that there is a market for the development or adaptation of software meeting regional needs.

Country (Internet-TLD-Abbreviation)	EU-15	AT	CZ	DE	ES	FR	IR	HU	SE	UK
Inhabitants in 1,000 on1.1.2002[a]	379,600.7	8,140.0	10,269.7	82,431.0	40,409,3	59,344.0	3,884.2	10,179.0	8,909.1	60,113.9
GDP at current prices and exchange rates in Million Euro 2001[b]	8,827,065	211,857	63,300	2,071,200	651.641	1,463,722	114,479	57,900	234,162	1,588,320
GDP per Capita in PPS 2001[c]	23.200,0	26,300.0	13,289	24,100.0	19,100.0	23,600.0	27,500.0	11,840	23,100.0	23,200.0
GERD as a percentage of GDP 2001[c]	1.94	1.86	1.33 (2000)	2.52	0.97	2.13 (2000)	1.2	0.8 (2000)	3.8	1.86
GBA[e]	0.77	0.66	n.a.	0.82	0,69	0.99	0.33	n.a.	0.88	0.69
ICT market value, Million Euro, 2001[f]	609,098	14,549	4,964	137,069	36,612	97,094	6,239	4,541	22,623	131,919
ICT market value as a percentage of GDP 2001[g]	6,90	6,87	7,84	6,62	5,62	6,63	5,45	7,86	9,66	8,31
Percentage of households who have Internet access at home 2002[h]	40.4	49.1	11 (2001)	43.7	29.5	35.5	47.9	-	64.2	45.0
Percentage of enterprises who have Internet access 2002[i]	79.46	84.95	-	83.92	82.56	58 (2001)	83.2	-	95.21	72

Table 2: General indicators on country differences

a Eurostat: Die europäische Bevölkerung im Jahr 2001. Pressemitteilung Nr. 95/2002, 7.8.2002, p. 3. Population in 1,000 on 1.1.2002.

b For the EU member states: Barcellan, R.: Das Bruttoinlandsprodukt 2001. In: Eurostat, Statistik kurz gefasst, Wirtschaft und Finanzen, Thema 2, 53/2002, S. 3; for the accession countries: Pasanen, J.: Quarterly accounts. Second quarter 2002. The GDP of the Candidate Countries. In: Eurostat, Statistics in Focus, Economy and Finance, Theme 2, 59/2002, S. 3 (http://europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=KS-NJ-02-059-__-N-EN&mode=download).

c As footnote b.

d Gross Domestic Expenditure on Research and Development. Eurostat: Allgemeine Statistik, Innovation und Forschung, GERD in Prozent des BIP, last update 14.1.2003, Version 2.00 (http://europa.eu.int/comm/eurostat/Public/datashop/print-product/DE?catalogue=Eurostat&product=1-ir021-DE&mode=download). Figures for Ireland and Sweden from: OECD: OECD Science, Technology and Industry Outlook. Highlights. Paris 2002, S. 2 (http://www.oecd.org/pdf/M00035000/M00035341.pdf).

e Government budget appropriation on R & D. Source: Laafia, I.: Staatliche Aufwendungen für FuE im Jahre 2001. Statistik kurz gefasst, Wissenschaft und Technologie, Thema 9, 5/2002. No figures for accession countries.

f EITO: European Information Technology Observatory 2002. Frankfurt: EITO, S. 401 ff.

g Own calculations from the columns "ICT market value, Million Euro, 2001" and "GDP at current prices and exchange rates in Million Euro 2001".

h Eurostat: Percentage of households who have Internet access at home. Last updated: 14-01-2003 - Version 2.00 (http://europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=1-ir031-EN&mode=download).

i Eurostat: Level of internet access - enterprises - Percentage of enterprises who have Internet access, Last updated: 14-01-2003 - Version 2.00, (http://europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=1-ir032-EN&mode=download).

2.2.2 The European Dimension in National Foresight

One of the results of the STRATA-ETAN High Level Expert group on European cooperation in Foresight is clear. "European polices and issue are not systematically taken into account in national and regional foresight studies" (Van Langenhove, 2002, p.45). By and large this statement can be confirmed by the analysis of the eight studies we have carried out. Given the orientation of Foresight towards the National Innovation System in most of the cases, this finding is not particularly surprising.

If we, however, take into account the multitude of European challenges and opportunities ahead, this finding is to some extent disturbing. For the example of IST, important aspects are: economies of scale to be achieved in the internal market, synergies and critical mass of research expertise through co-operation in the field of emerging technologies in view of ERA, the societal change towards a knowledge-based society and its employment effects, the emergence of European electronic B2C and B2B markets, interoperable infrastructures of ICT applications (e.g. mobile services, payment services), common security, privacy and data protection challenges, required common approaches to regulation, standards, and quality control.

Taking a closer look we do however find that some of these aspects are present somewhere in the studies, but in a very fragmented, not systematic way. Technologies Clés which deals with critical technologies is the only case where there is actually a systematic comparison of the French and the European competitive positions with respect to key technologies. Table 3 provides an overview of the treatment of the European dimension in these exercises, both for the overall exercise and for those parts dealing specifically with IST.

Country	European Aspects
Austria	Austria should participate in European standardisation for IST applications, "physical mobility"
	European cooperation on R&D should be intensifies
	European "sustainable development" policies responsible for Austrian innovations
	European research needed on "sustainable development"
	Policies on lifelong learning, medical technologies, physical mobility and structural changes of work may shift towards the European level, less national
	Common European taxation and social policies held responsible for "locational" competition between member states
	New materials seen as area for European research cooperation
	European level used to benchmark Austrian R&D
	European education software also potential field for cooperation
Czech Republic	Country has to adapt to the competitiveness of the EU environment
	Transport system being integrated into European structures
	Vision for societal development is "performance-oriented, safe and European integrated society"
	System of education requires adaptation to European university standards
	Danger of "brain drain" to other European countries
	R&D should be integrated in ERA

	Experts from other countries involved in preparation of foresight
France	Study analyses key technologies with respect to French and European leadership
Germany	Experts from some scientific areas emigrating to other European countries Extension of high-level education in cooperation with European partners Makes reference to IST programme – key action "essential technologies and infrastructures"
Hungary	All scenarios ("macro visions") foresee full integration of Hungary as part of global and European economic and political systems Steering group recommends that the long-term pace of advance should exceed that of medium developed countries in the EU, with an emphasis on knowledge-intensive sectors and health care The infrastructure should reach the level of developed European countries. Transport infrastructure is part of European infrastructure. Improve attractiveness of Hungary for European and other foreign investors. Anticipation that economical and environmental aspects will become more important as result of European integration. Domestic broadband network required to strengthen Hungary's ability to join and fully utilise the pan-European Internet2
Spain	The results of the Spanish Foresight Programme are directed towards the national R&D plan and at shaping the Sixth Framework programme and addressing structural funds of the EU. In the 2000 and 2001 reports, and in a special short document on ICT, the Spanish position with respect to different technologies and applications is determined in comparison with EU average.
Sweden	The domestic market is no longer Sweden, but Europe EU membership is numbered among "outside pressures" acting on the market.
United Kingdom	UK should be pro-actively involved in shaping EU policy and regulation Foresight results should inform UK's participation in Framework Programmes The government is urged to place more scientists, engineers and technologists in key areas of influence in Brussels. Attention should be given to partnerships and alliances. GRID Computing identified as major field for cooperation with EU partners.

Table 3: European Aspects in the National Foresight Studies

The two accession countries were obviously concerned deeply with the impact of membership in the European Union on their economies and society in general. The Hungarian foresight programme actually developed different scenarios dependent on the country's ability to come to terms with the new challenges posed by European and international integration.

A related aspect is the use of foresight to attempt to determine the future role of the country in the European science, technology and engineering landscape and consequently to identify niches for its industry building on the results of research strengths.

In some countries, notably the accession countries, but also Germany, there was a perceived danger of emigration of skilled personnel to other European countries. In Hungary and Germany, means to counteract this danger were being discussed. The Czech Republic seemed to

have resigned itself to the fact and was considering compensatory measures, such as attracting scientists, engineers and technologists from Asian countries.

In several countries, foresight was playing a role in determining priorities for participation in the EU Framework Programmes and also in shaping the direction in which the country wished to influence the writing of future Framework Programmes.

A number of science and technology related challenges are seen as too large for a single country to take on, and such cases are sometimes identified as an area for European cooperation, e.g. GRID computing in the UK programme.

A further European dimension is that of markets: domestic markets are no longer seen as sufficient to achieve and maintain status as a global player, and thus the "domestic" market is now at least seen as the European Union (cf. the Swedish study, which identifies a domestic European market for IT-related services).

The somewhat parochial nature of national foresight studies is indicated by the fact that they tend to ignore happenings in other European countries including the results of other foresight studies. The main use made of experience with foresight in other countries was in determining the design of the exercise itself. The European dimension is almost invariably underexposed, even in area such as IST, where the challenges of playing a global role are usually too awesome for any single country to tackle. The overall tendency in forming alliances appears not to be to look in Europe, but to attempt to interest the already existing global players, who are usually not located within the EU. A task for European level foresight would thus very definitely be to see if there is not more basis for creating European alliances to challenge dominant global players in some fields.

3 IST in National Foresight Exercises

3.1 Austria

Delphi Austria was regarded as a "search tool" to identify Austrian strengths in R&D, in particular to identify potentials and niches within technology, where Austria might find opportunities to achieve leadership within the next 15 years. As a result of comparative analysis of foreign Delphi exercises, and presumably the minor importance of the ICT sector for Austrian industry, there was no separate sector on ICTs. All items including applications of ICTs were included under other sector headings. A general finding of the Technology Delphi Austria was that organisational innovations tended to be ranked as more important than technology innovations. Since the publication of the reports on Delphi Austria, there have been at least two foresight-like studies on IST related issues: A report for the telecom company Mobilkom Austria on the future of mobile communications (Knoll et al. 1998), which was based on an international survey of experts, and a report based on a Delphi study on the impact of the "new economy" by the mafos consultant company on behalf of the Creditanstalt" (mafos, 2001).

Delphi Austria had no separate thematic field for IST applications and services, because the strength/weakness analysis of the preparatory studies, especially the patent statistics, revealed no significant Austrian strength. However, IST were treated as cross-cutting technologies in nearly every thematic field. IST were seen to be involved in nearly all promising innovations and developments, but as independent technologies only in a few niches. The field with the most IST applications was "Lifelong Learning", but the strongest impulses for IST innovations were expected in the field of "medicine". In this field the recommended policy measures were foremost a high-capacity and cost-efficient telecommunication infrastructure. The mentioned IST applications, that were considered to have a significant or at least modest importance and/or potential for Austrian leadership or which were recommended as policy measure, can be summarized as follows:

- Simulation software for development and production, in particular for new materials and vehicles including trains, as well as the promotion of its development, in particular in environmentally sound production, as policy recommendations.
- Specific IST applications in the mobility field, i.e. integrated propulsion management systems (e.g. for reduction of fuel consumption), diagnostic systems for the early-detection of damage to rail vehicles and superstructures, intermodal electronic billing systems on chipcards, IST-based roadpricing systems, electronic guidance systems for public transport, systems for freight tracking, and intermodal information systems (about time tables, tariffs, etc.). Important policy recommendations encompassed intensified application-orientated and interdisciplinary research, software development, optimisation of data interconnections, securing openness and compatibility of cross-border IST systems, participation in EU standardisation and European co-operations, governmental promotion of IST applications by pilot studies, public procurement, or venture capital provision, as well as intensified public-private co-operation and establishing contact points.
- Information infrastructure, databases and appropriate media to improve the education and training system, i.e. to improve the access to, the functioning of and advice for education, individual self-learning, vocational training and on-the-job training, e.g. by access and selection systems, multimedia workplaces, high-end network access, interactive tele-learning - also for learning groups or disadvantaged people -, international interconnectedness of education institutions. The IST-specific training of educators and teachers was related to this. Expansion of high-end communication networks, cutting of telecommuni

cation tariffs, support for user-friendly hardware and software, low-price access to content archives were policy recommendations.

- Information infrastructures for specific purposes on industry level to promote exchange of medical knowledge (networked health organisations), to facilitate exchange of knowledge for cleaner production or organic farming, to improve cooperative development (e.g. 'virtual pools' of companies), to provide a distribution channel and a network of capital-intensive technologies for SMEs in the field of environmental production, as well as to enable product co-development together with consumers via Tele-CAD.
- IST applications for medical purposes and the support of disabled or elderly people, such as the combination of IST and neurophysiology, intelligent diagnostics, rehabilitation technologies, eye-controlled and voice-controlled systems for handicapped and infirm people ('intelligent support' of sensory functions), or for medical prevention and early-warning. Policy measures to promote research in these fields were recommended, but also to secure privacy and data protection (health chipcard).
- Specific IST applications in the field of new materials, i.e. ceramic functional materials (as sensors, electronic systems with tailor-made micro-structures), online control for optimised production processes, optimised automatic welding, and tailor-made sensors. In this field, the establishment of new laboratories, the influencing of EU research policies, European cooperation, and the utilisation of synergies with electronics appliers were recommended.
- Installing special-purpose databases, e.g. for environmental data, medical information, about services for elderly, and facilitating public access to these databases were seen as important policy recommendations.
- A great part of the future political discussion was expected to take place in electronic media. However, new media was also held responsible for widening the gap between informed and less-informed people.
- Concepts of home control technologies (i.e. monitoring systems) for specific purposes, in particular for emergency issues and surveillance of elderly, but 'intelligent offices' and 'smart homes' was regarded as less likely.
- Concepts of tele-working had moderate importance and chances of realisation.

The range of IST applications and related policy measures, which were considered in the Delphi exercises, crucially depended on the initial selection of thematic fields and the formulation of topics within the thematic fields. This may have led to the problem of neglected fields of IST and specific IST applications and services (e.g. the entertainment industry) and to the problem of the bias towards societal problems and relevant IST which were most prominent at the time of selection. As a general result of Delphi Austria, the technological and organisational innovations, which were regarded as important or promising by the respondents, mainly had a modest innovation level. The criticism of a modest innovation level also applies to the considered IST applications, which were considered as being also relatively less innovative. The modest level was a consequence of the lack of time for preparing the questions, the lack of interaction (no "pre-Delphi" seminars or workshops were done), and the problem of closed groups.

Delphi Austria was useful to assess public evaluations of a given set of societal and technological trends and the problem-solving functions of IST applications which were pre-selected by the organising bodies and expert panels. It was also useful to assess the domestic R&D, economic and organisational capability to contribute IST applications for these specific fields, and also to assess the experts' evaluations of a given set of recommended policy measures. However, the creative and discovering acts were mainly in the initial formulation and selection of IST applications.

3.2 Czech Republic

The primary objective of the **Czech** foresight project was to prepare a National R&D Policy. The organisational structure included a separate panel on the information society, but IST were also treated in other panels. There is recognition that the country is heading for a "knowledge-based and information society", but treatment in the other panels was largely casual. The outcome of the project is a proposal for a National Research Programme, which includes five main thematic programmes, among them "information society.

IST were mentioned specifically in the main findings and recommendations as follows:

- **Thematic panel on agriculture and food**: proposes research on the development of IT and a "new economy" in the agrarian sector including food production.
- **Thematic panel on the environment:** no specific reference to information technology but does mention modern technologies for the environment, sustainable development and power engineering.
- **Thematic panel health care**: panel expects instruments to be miniaturised and information technology to be applied for telemedicine and the remote transfer of patient data. Among the research priorities singled out by this panel are technological aspects including sensors, medicine informatics and telemedicine.
- **Thematic panel on pharmaceutics:** recommendation for research on pharmacological informatics.
- **Thematic panel civil engineering, urbanism and housing**: recommended research priorities include the design of structures with intelligent behaviour and response and the development of new generation ground communication.
- **Thematic panel on materials and technologies for their production**: anticipates the growing importance of materials required for information technology, such as semiconductors and "intelligent" materials. The panel's recommendations for priority setting include research on intelligent materials and structures and the use of modelling in the engineering of materials.
- **Thematic panel on discrete manufacturing and products**: recommendations for research priorities include software engineering, production automation including measurement and control, mechatronics, the development of methods for product quality control and monitoring of production.
- **Thematic panel on modern instruments and devices**: recommends prioritising research on instruments and systems on the basis of modules with standardised interfaces as well as on various application areas dealt with by other panels, such as health care or the environment.
- **Thematic panel on the transport system**: priorities for research in this field include development of transport telematics and intelligent transport systems.
- **Thematic panel on "social transformation**": anticipates an increase in demand for so-called symbolical analysts of various kinds, including those specialised on Internet services. In the social system, the panel recognises the ongoing development of a "knowledge-based and information society", which is exerting pressure on the education system to adapt. The priority issues for research identified by this panel include international integration and globalisation, the knowledge-based society and new forms of education.
- **Cross-sectional panel on integrated research and development:** expects a major impact of the accession of the Czech Republic to the European Union, as well as a similar impact of the forces of globalisation. The panel expects the skilled labour force, especially re

searchers, to migrate in greater numbers ("brain drain"). To some extent, this could be compensated by an inflow of similarly skilled labour from non EU countries (particularly Asia). Research will be increasingly organised in "clusters" tackling large-scale, interdisciplinary projects. The overall development is toward the creation of a "knowledge-based society".

Thematic panel on the information society: expected a two-level use of research results in this field:

1. Export of know-how and software products with only minimum production in the Czech Republic using raw materials and energy.
2. Cooperation with strong foreign partners, mainly strategic investors. This would result in production, including software.

The panel also anticipated opportunities for the Czech Republic in the production of components, such as parts, transmitters, hardware for embedded applications and wireless communications, and sub-systems for man-machine interfaces. Networks and communications technology are expected to develop and GRID computing to become commonplace within the next decade. Mobile communications will continue to be of importance in the CR, there will also be a gradual transition to digital TV and broadcasting, with an extension of their use to services such as those in State administration or health care. The panel also expects the personal chip card to become commonplace within the next ten years.

The proposals for R&D priorities in their order of importance as identified by the panel are:

1. Systems for automatic control and data acquisition
2. Mathematical and computer modelling, simulation of systems, multi-media presentation.
3. Sophisticated integrated circuits and systems, modelling and description, complex systems on a single chip
4. Large scale systems for computing, databases and information
5. Artificial intelligence and its applications
6. Information and knowledge-based systems for health care and services
7. Sensors, activators and other types of human-machine interfaces
8. Electronic documentation for health care and social security systems etc.
9. Multifunctional communications networks with focus on safety and data protection
10. Digital television and audio broadcasting with application of terrestrial digital TV for interactive information services.
11. Reliability, diagnostics for materials for semi-conductors.

These research priorities were grouped into four sub-programmes for the National Research Programme.

The key technologies identified by this panel were: modelling and simulation tools, including virtual reality, embedded single-chip applications, automated testing of software systems and components, cryptographic techniques for transfer protection and security, software support for virtual enterprises, and finally, mutual interconnections between systems using wireless communication (e.g. Bluetooth, autonomous control and diagnostic systems.

The "materials" panel identified intelligent materials as a key technology with information technologies one possible area of application. The panel on chemical products and processes identified nano-technologies, specifically mentioning as one possible application among others "parts of computers of a new generation". Telematic systems in transport will be a key technology according to the "transport systems" panel, which also pinpointed electronic control, security and navigation systems.

3.3 France

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.

3.4 Germany

The German "Futur" project, which is the most recent project under the "foresight banner" in the country, is described as the "German Research Dialogue". Its starting point was a series of 9 workshops, which produced a collection of about 10,000 topics, that were classified by a list of 21 subject bundles comprising a total of 63 topics. The outcome were a series of "guiding visions" designed to provide input for the design of R&D support programmes by the ministry. These all contain aspects related to IST, with two visions strongly IST-oriented.

The vision on "Understanding Thinking" is oriented strongly towards learning, with a stress on research rather than such things as "learning services" or IST applications in learning. Among the technologies mentioned in the context were artificial intelligence, new computer architectures and algorithms, autonomous robots, artificial retina, inner ears and muscle control, and organic computing.

The vision "Creating Open Access to Tomorrow's World of Learning" is even less technologically oriented than the first, although there is a section on "e-learning" which does not have high priority in the overall vision. The question raised in this context is about suitable strategies for the application and evaluation of e-learning. There is a scenario for the year 2010 which makes little or only vague mention of technology (virtual laboratories, distance learning, education management tools, networks). Skills are an important factor in this vision as is prevention of social exclusion.

The "health" vision is driven mainly by the concern of "social cohesion" and access to preventive medicine for all. The only technologies specifically mentioned are patient chip cards and mini laboratories for home use. Obviously data protection and security are mentioned in this vision, but they do not play any major role.

The fourth vision "living in the networked world" does address certain key technologies and cross-cutting issues related to IST, such as man-machine interfaces and ambient intelligence, described here as "ubiquitous and invisible infrastructure". Mobile communication, broadband, electronic services, embedded systems and nanotechnology are also mentioned. A major vision for IST is that these should be personal, individual and adaptable. Confidence, trust and vulnerability are major cross-cutting concerns as is social cohesion which is treated in the shape of preventing the digital divide.

The man-machine interface is described at greater length with such aspects highlighted as intuitive support by the communications interface, artificial intelligence, cognitive science, microsystems, voice control, visualisation and displays including electronic or intelligent paper, sensors and the semantic web.

In connection with mobile communication, a need to address the issue of energy supply is pointed out. "Socionics" are mentioned as a new direction of research in the area of autonomous software agents, including robot systems. Another area of research covered by this vision is labelled "networks and the structure of services", which makes vague reference to ubiquitous and mobile terminal devices, personal networks, greater bandwidth and innovative services.

Technologies mentioned in connection with security include quantum crypotography and DNA crypotography based on molecular biology.

3.5 Hungary

There was a separate panel in the Hungarian Foresight Programme devoted to information technologies, while others dealt with sectors or social functions. IST were also debated in some of the latter. The recommendations are grouped according to their addressees and include many socio-economic issues, mainly intended to enable or facilitate the use and overall situation of IST in Hungary, and to ensure their widespread use throughout Hungarian society.

The subject of the IST panel was "Information Technology, Telecommunications and the Media", but several other panels also addressed IST in their work.

- **Panel on Production and Business Processes:** New materials will carry greater information content; the new generation of processing and manufacturing equipment will be digitally controlled; use will be made in product design of computer-assisted modelling; intelligent (computerised) measurement procedures and systems in the area of measurement technology will experience rapid growth; "data mining" techniques to search immense volumes of information and to identify relevant connections and relationships will be used in automated production; there will be a continued process of globalisation of design, production and distribution; application of artificial intelligence technologies in automated production will increase; the modern electronic economy is driven by information technology and logistics; information technology will become increasingly significant for Hungarian industry; company strategy, organisational structure and information flows will be subordinated to consumer requirements; the virtual workplace will gain importance. The panel's IT related recommendations are:
  - Creation of a system drawing on a nationwide network to provide advice on matters related to innovation.
  - Promotion of "knowledge networks" involving the Academy of Sciences, universities and businesses, presumably using IT networking tools.
  - Changes in the education system to meet challenges and needs created by new technologies.
  - Measures to develop less advanced geographical areas, including improvement of communications infrastructures.
  - Creation of an information infrastructure for suppliers.
  - Implementation of information networks to provide business with greater flexibility.
  - Development and installation of systems to support logistical operations, navigation and tracking.
  - Integration of information, communications (and logistics) into a system for waste treatment.
- **Panel on Agriculture and Food:** underlines the importance of these sectors for the Hungarian economy. The sector has considerable R&D capacities which have recently shifted emphasis from basic research to commercial services. The panel views this tendency with concern, especially since it sees a distinct danger of loss of know-how in the area which is much needed to improve competitiveness. It recommends the creation of a spatial database system containing all relevant information on land titles, environment, water supply, land use etc. Model farms are recommended as a means to diffuse new knowledge and technologies. Information on new technologies is regarded as an important means of enhancing the competitiveness of the numerous small firms active in the Hungarian food industry.

- **Panel on Health and Life Sciences:** addresses online services as a means of improving the efficiency of public health education, cautioning that internet access is not yet as "universal or widespread as in developed countries" (Hungarian Foresight 2002c, p. 12) and that most information is available in foreign languages (notably English). Distance education is likely to become the main form for delivery of permanent or periodical further education for health care professionals, with computer-assisted online examination used to assess student performance. Information technology is seen as likely to cause dramatic changes in the whole system of health provision with applications in diagnostics, medical instruments and robots, in addition to networks involving hospitals, health centres, general practitioners and even patients, for example in self-treatment. The panel devotes an entire section of its recommendations to IT, underlining that the application of information science and technology is a basic condition for effective care in the health services (cf. p. 22). In the panel's model, top-level information technology should be concentrated in regional and national centres. The panel further recommends the use of reliable epidemiological statistics, digital access to standardised diagnostic examination results, while avoiding multiplicity of parallel systems.
- **Panel on Protection and Development of the Natural and Built Environment:** recommendations include the following IT-related items:
  - The establishment of an environmental protection data bank, providing data on top-level environmental protection methods and clean technologies
  - Development and application of simulation methods and models for forecasting the impacts of environment-related decision and actions
  - Establishment of a database of sustainable development indicators to enable continuous environmental monitoring, involving remote sensoring and geographic information systems (GIS).
- **Panel on Transport:** recommendations on the maintenance and operation of the transport system include the longer-term introduction of electronic systems enabling the measurement of road usage and toll payment. Prior to the introduction of such systems, the panel recommends detailed assessments of public acceptance and economic risks. In connection with advanced technologies in transport, the panel sees a major role for information technology in increasing efficiency and reliability.
- **Panel on Education and Human Resources:** Hungarian teachers are described as being relatively unfamiliar with teaching methods based on student activity and said to have a "wait and see" attitude towards computers. Over half of the teaching force had, however, taken part in training courses on computer science and the Internet by late 1998. Little specific mention is made of ICTs in these recommendations, save the remark that "special efforts must be made to exploit the potential inherent in modern communications techniques and media for education purposes to increase the importance of distance learning" (Hungarian Foresight 2000d, p. 34).
- **Panel on Information Technology, Telecommunications and the Media**: the panel applied a shorter time scale to the scenarios than did the others. It also gave attention to links and interrelationships to the other sectors, underlining the horizontal and vertical relevance of this group of technologies for foresight. A third aspect picked out by the panel is the danger of social exclusion of individuals or entire societal groups denied access to, or unable to come to terms with, the new technologies. The panel identifies IST as the motors of future economic development and pointing out that sustainable development relies on the efficient exploitation of opportunities provided by the "information revolution". The main bottleneck according to the panel is not lack of financial resources, but lack of social readiness and acceptance. The panel sees a need for intensive public relations and information dissemination activities in this area of technology. The panel calls for an active role of the

state in ICTs and the media by providing support and encouragement for the development of the sector, and by creating a regulatory framework conforming to the standards prevailing in the European Union. The panel has four sets of recommendations, addressed to various actors. The state should**:**

- Create a harmonised legal framework for information technology, telecommunications and the media in preparation of the EU accession process,
- Formulate a comprehensive law in the ICT field with the participation of organised stakeholders with interests in the field;
- Exploit opportunities provided by ICTs for participative democracy;
- Maintain and upgrade existing large state-owned databases and formulate rules and principles governing the management of these databases;
- Support the Development of IT systems for use in health care;
- Develop an education strategy for the information society;
- Create a new legal framework for work in the information society;
- Support scientific research related to ICTs and the information society;
- Provide electronic access to libraries, museums etc.;
- Upgrade technologically existing broadcasting and transmission facilities for the public media;
- Apply advanced IT systems in public administration, law enforcement and defence;
- Apply IT systems in environmental protection and agriculture, land registry etc;
- Operate national awareness campaigns for the popularisation of IT and the notion of the information society;
- Reform taxation and customs regulations to facilitate the diffusion of ICTs.

The state and the "market participants" are recommended to:

- Formulate a strategy for the information age which takes both global and domestic developments into consideration.
- Co-finance a national information strategy.
- Develop high-performance networks for e-commerce meeting market needs.

"Society and the state" are the addressees of the third set of recommendations:

- Awareness measures of various types by societal groups and the government to prepare citizens for the challenges of the information society;
- Participation of societal groups in the formulation and implementation of the national information strategy;
- Formulation of ethical principles and codes for the information society;
- Management of tensions arising from changes due to the transition to an information society;
- Response to challenges and opportunities of globalisation, e.g. preservation of national cultural heritage and language;
- Creation of institutions or organisations to deal with issues of legal rights, protection of interests and personality.

Four recommendations related to the development of the ICT infrastructure are regarded by the panel as the joint responsibility of the private sector and the government:

- Upgrade and extension of the telecommunications network, rapid diffusion of advanced technologies and tools;
- Upgrade of the computer systems and networks infrastructures etc;
- Development of content services, in particular large databases;
- Development of applications, in particular in the areas of media and entertainment, e-commerce.

The final report by the Steering group underlines the central importance of knowledge in driving societal change, also arguing for "flatter", flexible and adaptive organisational structures in addition to a system for lifelong learning.

The final report also contains a total of 22 recommendations, of which several refer to information technology:

- Hungary should concentrate on highly knowledge-intensive sectors (p. 18).
- Among the skills regarded as vital is "application of up-to-date telecommunication tools" (p. 19).
- Formulation of a government programme for the development of human resources to facilitate the advancement of the information society. This is to include the improvement of IT literacy, to provide opportunities to access modern IT tools (e.g. in schools, libraries, museums or "tele-houses"), to provide basic IT education and training for the existing workforce, the introduction of subjects and methodologies based on interactive and IT tools into curricula, regular upgrade of the IT infrastructure in the education system (p. 19f.).
- Improvement of the domestic R&D infrastructure including the info-communications infrastructure (p. 21).
- Improving performance in information and communication technology (specifically mentioned together with biotechnology) (p. 21).

3.6 Spain

Spain is unique in as much as under the auspices of OPTI, an organisation close to industry, was responsible for the ICT sector studies, namely "La Fundación Instituto Catalán de Tecnología" (ICT). As Spain does not see its strength in developing basic ICT technologies the perspective was on the application level and the widespread deployment of applications. The three reports of the ICT panel focused on "Digital content industries" (1999), "ICT and the emerging digital economy" (2000), and "Convergence of infrastructures and services in the telecommunications sector" (2001). ICT was also a topic in other sector studies addressing especially the potential of ICT with respect to modelling, design, simulation, control, and remote services. In addition, a study was devoted to the changes by automation in traditional branches. It is worth noting that the strong industry orientation is very visible in the composition of experts with about 80% of experts addressed in the Delphi surveys coming from industry.

ICT in the OPTI studies 1999-2001

Digital content industries (1999): Taking a closer look at the focus of this prospective study it turns out that digital content industries are understood in a very broad sense including all activities which have to do with the generation, production, processing or distribution of digital content. Software developers and telecommunication operators are thus included. In addition, the questions raised in the Delphi survey appear to be quite general and seldom specifically focussed on eContent issues.

The general picture derived from the Delphi exercise is the following: Massive use of ICT applications in the professional environment is expected already till 2003. This includes widespread use of professional information sources, use of intelligent agents, e-mail use as very important for inner organisational communication and also the use of multimedia editors to produce content. High speed internet and broadband networks are important for the further development of the infrastructure to carry digital content. Infrastructural change is however a mid-term undertaking going on rapidly between 2004 and 2008. The common technological platform will be the internet plus intranets and extranets. The development of accompanying measures like broad use of encryption and digital signatures or the establishment of appropriate tax regulations, intellectual property rights, and further laws is also a mid-term expectation. Looking at specific applications, e-commerce, telework, distance learning, G2C services, health services, and virtual communities are all expected to take off in the medium term.

Spain's level in science/technology, innovation, production and commercialisation is regarded as medium in the European context. Although most technologies are imported, skills and opportunities are identified regarding development of software and applications, and their diffusion into businesses. The authors of the study are in favour of more deregulation of the telecommunications area to achieve more competition and lower prices, and at the same time better quality and faster construction of a high-speed broadband infrastructure.

With respect to the digital content industries the authors see promising perspectives with respect to industrial development and to quality of life. The future seems to be bright especially for big publishing houses and media companies, while opportunities for SMEs depend on the proper identification of niches. As most important measure to improve industrial development more cooperation between industrial companies and R&D centres is recommended, and increased support from public administration.

ICT and the emerging digital economy (2000): This study endeavoured to find out how the Internet changes value chains in many sectors and how this leads to new business models. The focus of the study is on the application level in four areas: Internet as basic infrastructure, development of electronic commerce, supply of digital goods and services and B2C retail markets of tangible goods.

In the term 1999-2004, an explosion of B2B commerce is expected in many economic sectors. It is also expected that access to internal company information via Intranet as well as to external sources via portals will be commonplace. To support the information search, a role for software agents seems likely. In addition, considerable growth of e-commerce is expected to which mobile applications should contribute considerably. It was said that WAP would play an important role (2000, p. 388).

For the time between 2005 and 2009 maturation of B2B commerce is expected with the integration of front-end and back-end systems. The development of extranets allowing for the integration with external partners, suppliers and clients, will contribute to this B2B development. The present corporate culture with an aversion to change and the organisational structure of companies are regarded as barriers. One of the major problems is also a lack of qualified ICT personnel, but this problem, following the authors, should be resolved in medium term by suitable actions of formation and education.

In the B2C area, barriers to the development of e-commerce seem to be the present shopping habits, little experience with distance selling, lack of trust, perceived risk of fraud, lack of technical knowledge together with complexity of technical solutions.

The findings of this report are to a large extent congruent with those of 1999, although more statements seem to depend on “Zeitgeist”.

Processes of technological convergence in the field of ICT (2001): In the 2001 study, the Internet is seen a one of the principle motors of convergence. It is expected that 3G mobile networks and fixed Internet will converge. The future infrastructure is envisaged as broadband at reasonable costs.

In the timeframe 2001 to 2005, growth of e-commerce and particularly electronic markets is expected as well as the integration with back office applications. Interestingly, geographical services are regarded as type of “killer application” for 3G mobile. A new wealth of personalized mobile services which adapt to the location where the user is, are expected. Also Bluetooth is expected to become the de facto standard avoiding cables between devices, making their use more simple and convenient.

For the time span 2006 and 2010, all communication networks will migrate towards IP technology and will be used for all media types. Broadband in place, streaming of quality video and audio data is expected at moderate prices. In addition, e-Commerce via interactive TV looks promising and generalized use of 3G mobile phones with multimedia capacity and easy to use man-machine interfaces are expected.

Spain is prepared for mobile services and interactive TV at the level of infrastructure and services. It is held that this future can be predicted based on the good acceptance of 2G mobile phones and of digital TV already today. The “hype” of mobile communication and m-

commerce is apparent in the findings. Even so, the difficulties of UMTS to take off because of the financial situation of most operators are also recognised.

Technologies of automation in traditional industrial sectors

This study on automation in traditional industries, based on a Delphi survey in 1998, was coordinated by INESCOP (Technological Institute for Footwear and its Related Industries) covering a broad spectrum of traditional industries. Traditional industries are composed of 40,000 companies with about 600,000 employees. Most of the companies are SMEs and have an average of 14 workers. A panel of 18 experts had by brainstormings defined 75 topics, which were later reduced to 30. 147 experts were addressed in the Delphi exercise with 75% coming from industry. 82% of experts came from the region of Valencia, which is famous for its traditional industries.

In terms of ICT implementation and deployment in the traditional industries expected till 2004 the study pointed out:

- computer networks for the internal communication of companies were regarded as very important;
- business software and applications taking into account the special needs of specific sectors and the needs of SMEs;
- advanced rapid prototyping technologies, which were regarded as very important for industries to increase productivity. The creation of industry specific prototyping centres for SMEs was recommended;
- Real time quality control systems were regarded as developments important for these industries;
- The use of robots and automata in the warehouses of SMEs were regarded as most important for employment in traditional industries. The authors however do not clearly state if their finding implies the creation of new jobs or the loss of old ones.

Expectations ranking high for the period 2005 to 2009 were that:

- automation in these industries would lead to more healthy jobs,
- the new skills needed would lead to higher qualifications of the workforce and more flexibility within the company;
- automatic process control in the phases of planning and programming of production would be important for the development of industries although not in place today;
- simulation of the entire production process was regarded as important for industrial development;
- the establishment of sectoral centres for collection and recycling of specific residues was regarded as important for quality of life and the environment;
- the strength of Spain in mobile localisation technologies was expected to lead to the optimisation of transport.

All in all, automation in these industries is highly required to keep pace with competitors. The type of worker needed will change, and the low qualification of most workers at present might turn out as a barrier to change. A special study on the effects of the labour demand is recommended, following the opinion of the study, no increase of employment seems likely, however.

ICT in other sectors

The first OPTI study (1999) identified technology trajectories for the different sectors studied. In the following (Table 4) we depict those technology trajectories which indicate the application of ICT.

Sector	ICT based technology trajectories
Agro-food: Technologies for food conservation	Modelling of external and interior factors of influences for technology optimization
	Development of rapid methods for analysis and control
Energy: Renewable Energy	Automatic remote control systems for centres of mini hydraulic systems
Environment: Management and treatment of industrial waste	Development and application of systems for environmental management
Fine Chemistry	Simplification and automation of processes
Information and Communication Technologies: digital content industries	Interactive broadband networks
	High speed Internet
	ATM telecommunication networks
	Encryption
	Digital signatures
	Expansion of domestic applications
	DVD
	Generalization of Java
	Extension of Intranets and Extranets
Transport: Air	Technologies of design and modelling
	Integration of high end computing systems, wireless and communication via satellite
	Systems for air transport management
Basic and Transforming Manufactures: Metal processing	General application of laser technology at industrial level
Traditional Industries: design technologies	CAD systems integrated with production systems
	Integration of simulation facilities into CAD systems
	Sector specific CAD/CAM beyond general purpose software

Table 4: ICT technology lines for different sectors (OPTI 1999)

The summary of the third OPTI report (2001, p. 411f.) highlights eight fields in which ICT is crucial in non-ICT sectors (Table 5). The potential of controlling, monitoring, simulation, and remote services are mainly pointed out here:

Sector	ICT based developments
Agro-food	Consumer information systems on food
Energy	ICT for monitoring, controlling and simulation of transport processes, distribution, storage and final use of energy
Environment	Dependable and transparent information systems about reuse of water
	Monitoring and on-line control technologies about water resources
Fine Chemistry	Maximum automation of paper industries
Transport:	Increased speed of car design and development
	More flexible fabrication; standardisation of major components
	Telematic control systems for the rational use of and intelligent distribution of different traffic systems
Basic and Transforming Manufactures	Added value services for machine-tools operated by the manufacturer like tele-services, tele-maintenance, communication, and access to technical data via broad band Internet

Table 5: ICT in non-ICT sectors (OPTI 2001)

Despite the interesting findings, due to the parallel organisation of studies, no overarching vision on ICT has been developed by OPTI.

3.7 Sweden

One of the eight panels of the Swedish foresight project was devoted to information and communication systems, albeit from the "user perspective" which was employed for all panels in the project. Obviously most of the other panels also addressed IT related aspects of their subject area. An important factor to consider in all assessments of the outcomes of the Swedish Foresight Programme on IT is the existence of an IT commission at government level. The commission which changes regularly in its composition has already addressed very similar questions to those guiding work on IT in the Foresight Programme**.**

The main results from Swedish foresight on IST are summarised in the following.

- IT will play an increasing role in the health care system, e.g. by providing patients with information about their diseases, as a tool for home care, by enabling communication between health care professionals at all levels. Security of IT systems is singled out as a particular problem in this area.
- IT is mentioned in connection with better all-round utilization of biological natural resources. The panel for this topic also recommends concentration on the development of products with high knowledge content, which highlights the importance of human knowledge in the oncoming knowledge society.
- With relation to society's infrastructure, IT is mentioned as the main tool for upgrading transportation, providing "completely new 'intelligent' ways of utilizing existing facilities more efficiently, but also of making traffic safer and more environmentally friendly" ("The Foresighted Society", p. 38).
- Mobile telephones are mentioned as one of the mainstays of Swedish industrial production. IT is regarded as a major driver for reforms in traditional production systems. Telecommunications and mobile equipment will facilitate close global collaboration. ICTs are an essential component of "virtual companies". Intellectual capital is regarded as the most important asset for competition and this requires working tools and procedures frequently enabled by ICTs. Microelectronics, computer and communications technologies are seen as the basis for entirely new products, simulation and modelling are identified as elements determining new working methods. In addition, "products are being given a large knowledge content…" (p. 41). A major expansion of communications systems is regarded by the panel as an important prerequisite for Sweden's future position. The panel also draws attention to the need for companies and organisations to adapt to network based projects and to rapidly increase the IT, software and service contents of their products.
- Information technology (e.g. search engines) in connection with global development is seen by the materials panel as one of the reasons for the greater availability of many raw and standard materials (p. 46). Sweden is described by this panel as an attractive test market for new products, due to the population's high degree of IT adoption among other things. Smart materials combining modern semi-conductor technology with materials technology are identified by the panel as a priority area for Sweden in the future. Computer simulations are, as elsewhere, an important tool for technological advances in materials.
- The services panel draws attention to the rapid growth of this sector, which is due to a large extent to new technology. The "home market" for such services is increasingly the whole of Europe and not simply Sweden. The panel suggests public subsidies for home computers and broadband to provide all inhabitants of Sweden with access to the Internet.

This panel also addresses the subject of teleworking from home. Such homes could also be more "intelligent".

- The education and learning panel regards information technology as a means to meet the challenges posed by societal change, provided it is adapted to people's needs. IT has a role to play in pedagogical development and for the dissemination of information. Modern technology is also viewed as a means to develop critical and constructive thinking. The IT age calls for an adult education system.

The IT panel was among those which set its sights on the next ten, rather than twenty, years. It formulated visions of futures of society and described the technology required to achieve them. This resulted in the identification of seven key areas regarded to be of great importance for the future evolution of ICTs.

- Always online: this refers to the development of home networks, wireless communications, the convergence of different media. Among the challenges are providing greater bandwidth and adequate human-machine interfaces.
- Digital assistant: this refers to software required to examine and interpret information and to adapt it to the situation and the needs of an individual user.
- More and more is becoming software: refers to the replacement of hardware by software. There is a need for new methods of programming, packaging, distribution and recycling of software as well as a need for greater attention to be devoted to the design of intuitively usable interfaces.
- Services of the future are electronic: meaning the possibility of customizing goods and services by means of improved software tools and information-based services that presuppose electronic communication.
- Continuous and immediate learning: refers to the blurring of distinctions between education and work, entertainment and learning.
- The technological and the biological worlds meet: denotes developments in the borderlands between ICTs and biotechnology.
- Security and privacy: covers the issues of vulnerability and mistrust of individuals of ICTs due to their potential for information gathering and surveillance.

The panel's main recommendations include:

- The creation of a Swedish "IT university" with an emphasis on mobile telecommunications systems. As an organisational form for this university, the panel proposes a number of nodes tied together in a network. This network should also collaborate with other universities and institutions of higher education. The panel also urges for closer collaboration between the universities and business, e.g. through the exchange of teachers and further education programmes. The panel further recommends training multi-disciplinary programmers capable of developing software tools at a university of the type proposed.
- Wiring up the country's schools to put them online, thus promoting development and stimulating new meeting places. The panel proposes starting this process with universities and colleges, eventually extending it to the compulsory and secondary schools.
- Building expertise and applications in molecular electronics based on biomolecules as building blocks for electronic functions. This again requires the creation of interdisciplinary environments and research programmes.
- The panel identifies a particular demand for IT interfaces, in particular those involving all human senses. It therefore proposes an interfaces programme, preferably under the auspices of the Interactive Institute.

- The creation of a project or research programme on systems science for groups of autonomous systems, consisting of physical and mechanical robots, software agents and autonomous systems. Potential applications for such systems are seen in areas where large quantities of data require interpretation, e.g. in e-commerce, healthcare or self-care.
- The creation of a network on security and privacy in information systems, involving both the business and public sectors. The network would be responsible for the "follow-up and analysis of deliberate attacks throughout society".
- The development of a strategy for travellers and transport systems to be always on-line. Building blocks of this strategy are electronic services, sensors and adaptive systems tailored to travellers and traffic systems. Among the tasks to be tackled would be the provision of information on the traffic situation and accident risks. At a later stage, the strategy seeks to involve other partners such as the automotive industry and logistics companies.
- The development of a strategy for IT in the health care and social service sectors. One element of this strategy is a programme for home health care and involving researchers, companies and public institutions in the joint development of innovative products and services for care providers, other affected institutions and the patients themselves. Pilot projects operated by hospitals are part of the strategy recommended by the panel to experiment with milieus involving IT solutions. One such milieu is the "intelligent bathroom".

3.8 The United Kingdom

In the second cycle of UK Foresight, the panel on Information Technology was officially titled "Information, Communications and Media" (ICM panel). This included a working group on "Information Technology, Electronics and Communications" (ITEC). The final report by the ICM panel entitled "Let's Get Digital" was published in December 2000. There was also a consultation document, "ITEC Technologies", by the ITEC. This document was intended for broad discussion. The ICM panel published the following reports:

- Information Relationships Report - The Importance of information relationships as the online economy develops
- ITEC Report - Technology issues in the ITEC sector and what business, government and academia can do to support and enhance the UK's competitiveness
- Let's Get Digital - ICM Panel Final Report - Final report and recommendations for maximising the economic and social opportunities from new digital technologies
- ITEC Vision - The effects of technology in everyday life
- Smoke on the Water - A Fire in the Sky - E-commerce Task Force Consultation Report - How Britain should prepare for the coming world of electronic commerce, communications & connections
- ITEC Technologies - How life and work may change through developments in ITEC
- Universities in the Future - University education of the future - paying particular attention to the needs of socio-economic groups

The report by the ICM panel identifies four pre-conditions for the maximisation of the social and economic benefits of new digital technologies:

1. **Critical mass**: the UK is seen as too small a digital economy to make the country a global leader in the field, thus it is important to ensure the interoperability of systems and devices to avoid fragmentation.
2. The Internet is leading to the emergence of **new business models and practices**, so it is vital for UK businesses and the Government to understand the economic dynamics of the networked society to take advantage of change and to create new markets.
3. **Citizen empowerment**: Access to the Internet and broadband communications are regarded as vital for citizens to gain experience and confidence with digital technologies.
4. **Highly skilled workforce**: This is required to develop and service the new economy and is a matter of education and training taking full advantage of the opportunities of the new technology to provide personalised education and training. This has both a technological aspect and an aspect related to the flexibility and adaptability of the education and training systems.

Apart from the ICM panel, IST figured highly in the work of such task groups as integrated transport chain futures, chemicals in IT, infrastructure for financial services, technology and communication in the food chain, biotechnology and medical devices, the learning process, retail e-commerce, and the task forces on ageing and crime prevention.

There were eleven main areas addressed in the recommendations of the ICM panel:

1. The development of universal broadband access is regarded as too slow if left to market development based on private initiatives. The panel recommends a Government analysis of the impacts of creating universal broadband access itself.

2. "Attention" and data of individual users are seen by the panel as an emerging new "currency", which may be traded by consumers in return for goods and services in much the same way as cash. Current data protection regimes are seen as a barrier to this development, and the panel urges for an adaptation of existing laws to enable consumers to balance their right to privacy with the ability to control and trade their data more precisely.
3. Development of an understanding of newly emerging peer-to-peer economic and social activities.
4. Adaptation of competition policy in conformity with the needs of global markets.
5. Empowerment of consumers through digital and online applications in education, encouraging the growth of the "attention" economy, ease of use of services and applications, special assistance for the disadvantaged to participate in the network economy.
6. Fiscal policy for growth, in particular to encourage technology-led start-ups and to ensure the attractiveness of the UK as a location for technology-driven investment.
7. Regulation for growth and sustainability, more specifically urging for internationally agreed open standards in electronics, computing and telecommunications.
8. ITEC education, skills and training: A major problem apart from general IT literacy is seen in the shortage of skilled manpower for ITEC professions.
9. The creation of universal broadband networks for learning is regarded by the panel as a Government priority.
10. New roles for education and teaching professionals are needed, in particular involving the use of new technology.
11. The panel recommends the creation of a "Broad Church of Learning", involving both official institutions and citizens' homes. The panel recognises the opportunity for the UK to be a "centre of excellence" in developing learning materials. Private and state providers of qualifications should be accorded equal recognition.

A large part of these recommendations are obviously driven by concerns about e-commerce, which was at the forefront of attention from the stock exchange and the popular press at the time of the foresight cycle.

Although the points contained in these recommendations are still valid, most are probably not as urgent as suggested by their inclusion in a short list of 11 items. The other major concern indicated by the recommendations is education and training, at both the level of general IT literacy and the professional level. This illustrates not only the difficulty to escape from the traps of "Zeitgeist" but also that of focusing on a long time horizon.

4 Overall Results on Information Society Technologies

4.1 The Technological Viewpoint

The findings of the comparative review on Information Society Technologies are reported from three different angles or viewpoints. The first is the technological viewpoint, which is itself subdivided into three aspects: technology in the narrow sense, application areas, and technology related societal issues. The second viewpoint is concerned mainly with strengths and weaknesses identified in the foresight studies for each country. An analysis of strengths, weaknesses, opportunities and threats (SWOT) is a standard element of foresight studies, but as the findings show, the available information on opportunities and threats is extremely limited. The third angle concerns visions, which are again an important element of foresight studies. Again, the reports do not contain much information on such visions, if they were indeed developed. This element will be examined in greater depth in subsequent work on existing foresight exercises.

A list of the results of the national foresight studies on IST would contain many items of very variable quality, such as "artificial intelligence", "navigation systems" or "regulation of privacy". The development of grids for the classification of such items is always controversial and subject to criticism so that the schemes used here are subject to revision for the final project report. Workpackage 2 is working on a taxonomy which could be employed for the purpose, as could the proposal for "research clusters" contained in the ISTAG publication "Scenarios for Ambient Intelligence in 2010" (Ducatel et al. 2001). Hence, the scheme employed here is pragmatic and as much as anything reflects the results of the sample of studies reviewed here.

It is possible to distinguish at least three dimensions to categorise the results:
1. The technological dimension, which encompasses what will be classified as "technologies" and "functionalities" in workpackage 2 of FISTERA (http://fistera.telecomitalialab.com).
2. The application dimension, which combines the "services" and "ambients" dimensions of workpackage 2.
3. Cross-cutting issues, which are mainly conditions for, or the results of, applications of IST in practice.

Thus, the findings of the national foresight studies on IST have been summarised in three partially overlapping groups:

1. Findings on technology (cf. table 6)
2. Findings on application areas (cf. table 7)
3. Findings on "cross-cutting" issues (cf. table 8).

Findings and recommendations referring directly to technology have been grouped under the first heading, which usually identifies those areas of technology regarded by the foresight participants to be of particularly importance to domestic research and industry. These are thus areas in which the foresight study indicates that the country has particular strengths.

The second heading applies to results of foresight studies referring to distinct application areas of IST, making a distinction between home/private use, business/work use and use by government. In some cases this implies that the country should be actively involved in developing applications in this area, but at least that such applications should be tailored to meet the specific needs of the country in that application area. This could also be construed as an invitation

for foreign developers of application software to home on the needs of that country. In other cases the implication is that certain sectors of the economy have to adopt IST in their operation to retain competitiveness or to keep step with the transition to the information society.

The third heading is used for such socio-economic concerns as privacy and vulnerability, social cohesion or exclusion due to "IT readiness", the legal framework etc. The sub-headings employed for this table to some extent reflect the priorities of the fifth and sixth framework programmes of the EU and the Lisbon and Göteborg objectives, even if some of the foresight programmes were completed or underway before these objectives were agreed.

The following tables (Table 6, 7, 8) summarise the findings of the foresight exercises on these areas, mainly identifying items of particular importance to the country in question.

4.1.1 "Key" Technologies

In keeping with the socio-economic orientation of the majority of the foresight studies reviewed, the reports contained comparatively little on emerging key technologies, which might play an important role in the future, but whose full potential is at present difficult to assess. As pointed out earlier, there are probably future-oriented methods better suited to identify promising technologies, but it would obviously be of great advantage to decision-makers on science and technology policy to have some indication of the applications and uses envisaged by industry, but also by the "end-users" for such technologies.

Those studies focused most clearly on identifying subjects worthy of support, such as the Czech and German studies, obviously have a stronger focus on technology than those seeking to establish networks or industrially oriented. However, the processes leading to specific recommendations in the Czech report are not sufficiently documented to determine which other technologies were considered. In Germany, the very process employed for the study meant that other candidate key technologies were "eliminated" through the interactive process before the study "homed" on scenarios containing technology thought to be promising as a means to achieve a good position in research. The scenarios resulting from the process are not particularly technology-specific but do provide scope for the support of projects contributing to progress in key areas of technology, such as artificial intelligence. However, the main focus here is on "understanding thought processes" to improve learning and teaching methods.

Established industrial countries, such as Germany, Sweden and the United Kingdom, indicate interests in such advanced fields of research as bio-computing. However, most statements regarding such technologies are at a very general level: "As for the use of biomolecules as electronic materials, numerous challenges remain to be mastered before these techniques will be functioning and commercially viable" (Swedish Foresight: The Foresighted Society, p. 44).

The United Kingdom foresight, in its paper by the ITEC group, describes such technologies as "disrupters": technologies that currently do not seem to offer many advantages but which have the capability to change the landscape completely when they come to fruition. The ITEC paper specifically mentions quantum computing as a research area having strong potential impact on information transfer, processing and security. "Although it is difficult to assign timescales to the application of any of these techniques, their ultimate potential may be large. Spin states of materials provide a plausible physical medium for the desired processes, but practical computing devices are still far off. The UK has potential strengths in the relevant research fields: both quantum communication theory, and the kind of skills needed to fabricate research-scale

devices" (UK Foresight, 2000a, p. 25). Elsewhere in UK foresight, optical computing is quoted as an example of a technology not yet having fulfilled its early promise (ibid.).

The ITEC paper is even more unspecific on molecular computing (for example using DNA) which it describes as an interesting example of biology feeding back methods into ITEC. This is seen as at too early a stage to judge its potential (ibid.). This illustrates once again the difficulty of foresight activities of the participative kind to come to terms with the long-range future.

Artificial intelligence is regarded as a promising field by the Czech study, but also at a more basic level in the German "Futur" study. While it is not particularly stressed in the Second UK Foresight Cycle, AI, in the shape of "cognitive systems" is one of the subjects singled out for attention in the first round of the *third* cycle.

The Czech Republic, Germany, Sweden and to some extent France focus on human-machine interfaces. The two accession countries see opportunities in the areas of computer simulation and modelling, which exploit the countries' traditional excellence in mathematics and physics. Sweden also sees this as an opportunity. Several countries also see opportunities in the creation of complete systems, including complex systems located on a single chip.

Although not strictly speaking an Information Technology, Nano-technology is most definitely an Information Society Technology, with applications in many fields including ICT. It is mentioned in most of the studies:

- Czech Republic: nanotechnology is mentioned as a key area of technological research in medicine and as a component in the miniaturisation of analytical techniques for pharmaceutics. Nanomaterials and nanotechnologies are the first priority key research area proposed by the panel on materials and the technologies of their production. Nanotechnologies are also areas of key research prioritised by the panels on instruments and devices (instruments and equipment for micro-and nano-technologies, nano-layers for instrumentation) and chemical products and processes whose fifth ranking priority is nanotechnologies.
- Hungary: nanotechnologies are expected to bring about the "industrial revolution" of the next 10 to 15 years. Hungarian research on nanotechnologies will comprise of follow-up work on primary research work done elsewhere. The aim of this work is to train specialists required by the new industrial firms operating in the country.
- Sweden: in connection with materials, the final report states "Nanotechnology – atomcraft – is a breakthrough field in which researchers are now trying to handle materials at the atomic level. This may yield completely new materials with new characteristics and functions" (The Foresighted Society, p. 10). The use of nanotechnology is envisaged for semiconductor surfaces in bioimplants. The report recognises new opportunities through nanotechnolgy and awards high priority to creating new materials on a nano-technology basis.
- In the UK, the foresight programme claims that the Materials Panel played a key role in gaining acceptance of nanotechnology as one, if not the, key area of technology for the future. This claim is underlined by Wood (2001) for the first cycle of UK foresight. An early report by the materials panel in the second foresight cycle bears the title: "Opportunities for Industry in the Application of Nanotechnology". An important application area are health services for diagnostic and monitoring devices and other instrumentation. The UK sees opportunities to manufacture the machine tools and instruments necessary for

manufacture at the nanoscale. A major need is to convince investors of the benefits of nanotechnologies.

Not surprisingly, Sweden identifies mobile communication as a mainstay of its economy and is in the process of setting up an IT university specialised largely in this field. Mobile and radio networking is also an area targeted by the United Kingdom. Hungary sees an opportunity to regain its former strength in the area of communications. In this case, its major asset are the skills and knowledge of specialists in the field, which it would like to keep in the country. The foresight study suggests attracting foreign investors to set up research and development laboratories in Hungary could be a suitable means to achieve this.

At a slightly different level, the Austrian study has been criticised for focusing mainly on areas where Austria could play a leading role. It has, for instance, since emerged that mobile communications and related services offer great potential for job creation, even if the country does not play a leading role in the field. As a result, at least two foresight-like activities have taken place on mobile communications.

The analysis has revealed that foresight studies of the type considered here have not yet developed adequate methods to enable participation of stakeholders in determining key technologies which will play an important role in the mid- to long-term future. Further work in this field might investigate similar approaches to those employed in the "Young Foresight" programme which has been created in the aftermath of the British Foresight Programme. A major part of that programme's toolbox are educational videos explaining such unfamiliar technologies as nanotechnologies and possible applications, in this case to students attending normal schools. If successful, such approaches could be adapted for other target groups and employed in foresight-like studies.

Country / Type of technology		Austria	Czech Republic	France	Germany	Hungary	Spain	Sweden	United Kingdom
Enabling research			**Mathematical and computer modelling Artificial intelligence Materials for semiconductors Intelligent materials and structures Nano-technologies**		**Socionics DNA and quantum cryptography Computational neuroscience Systemic biology**			**Systems science**	Maths, physics Computer theory Software engineering
"New generation"				**Optoelectronics Photonics**				**ICTs and biotechnology converging Molecular electronics**	Optoelectronics Grid computing
Existing Technologies	Hardware		**Sensors, actuators Human-machine interface**	**Silicon microelectronics Intelligent sensors Mass memories**	**Human-machine interaction Mobile devices Visualisation, display techniques Energy supply**			**Mobile telephones as « mainstay » Human-machine interface**	Powerful portable PC Advanced visualisation/displays Data storage/maintenance Low power devices
	Software	**simulation software**	**Simulation software**		**Information logistics Software agents Computer simulation**	**Modelling Simulation**	**Operating systems (Spain with poor position) Application software, software engineering (Spain medium)**	**Simulation. Modelling New methods**	Reliable and flexible software Creative industries: content provision, design skills, computer games
	Systems		Large scale systems Complex systems on single chip Communications networks	Microsystems	Embedded systems Microsystems Networks			Networks; Convergence of media; Greater bandwidth Autonomous systems	Broadbands Mobile/radio networking

Table 6: Information Technology in National Foresight Studies

4.1.2 Application Areas

The main application areas for IST were health, education, transport and government in general. E-commerce was creating a major stir at the time of several studies and thus is also given much attention. Some foresight studies also addressed the vanishing boundaries between previously separated spheres of daily life, such as work and leisure, leisure and learning, with "infotainment" emerging as a separate category at the interface between information and entertainment. Some countries, notably the UK, felt that they could capitalise in other areas their expertise and experience gained in such areas as computer games. These are obviously also an economically attractive field on their own virtues.

The Austrian and Swedish Studies particularly address the potential of IST to form new working relationships, such as "virtual" companies. This is obviously of importance for future competitiveness of the small and medium-sized companies which dominate many European economies. In this connection, teleworking is also mentioned, although it has been predicted to break through for something like twenty years or more. The changing face of global economy might however now at last be creating the conditions which favour the emergence of telework.

Over all, the major application areas for IST were at the same time usually those high on the political agenda for other reasons, e.g. health care and applications for the elderly. Health insurance and health care systems in many EU members states are faced with a crisis, in which IST can offer partial solutions. In addition, populations in almost all European countries are ageing, drawing attention to potential use of IST in retaining independence of the elderly, but also to the need to design IST specifically for older users. Other examples are transport, government and governance, and the environment. The cross-cutting issues addressed in the studies are also usually those high on the political agenda, e.g. privacy and vulnerability, sustainable development, education etc. In such cases, urgent needs might again produce solutions that can be applied, and thus marketed, elsewhere.

Finally, it is important to underline that some countries saw few opportunities in the production of IST, except in very limited niche markets, but for most the application of IST by industry was regarded as important for future competitiveness in virtually all of the countries covered. It was a major subject both in Spain and in the UK, where separate reports on the topic were produced.

Country Areas	Austria	Czech Republic	France	Germany	Hungary	Spain	Sweden	United Kingdom
Individuals/ home	**Diagnostic/monitoring technologies for the elderly; Information Databases; Communication technology for ageing; Intelligent support of body sensory functions; IT for lifelong learning; Self-learning media; Domotics (smart homes, ome information systems)**	**Digital TV; Navigation systems; Security**	**Audio-visual (games, DVD); Large flat dsiplays**	**"Body area networks"; Video-on-demand; Location-based services**	**Content services; Media and entertainment; Health care**	**eContent**	**Health care (patient information) Electronic services Education/work/leisure converging**	Balance between home/workplace; Growth of new online cultures; Health: remote diagnosis, advice, body monitoring; Virtual reality; Video games; Consumer access to GPS; mobile computing; mobile data
Business/ work	**Use of Internet: teleworking, virtual pools of companies; Simulation and planning software**	**Agriculture; Optimisation of product design; Production automation; Mechatronics; Quality control, monitoring**	**Use of Internet**		**New materials with information content; Processing and manufacturing equipment; Data mining; Measurement; AI in production; Virtual workplaces; Databases for agriculture; Content services; Media E-commerce**	**Payment systems; eCommerce; IT in traditional sectors**	**Virtual companies Service delivery Teleworking Education, learning Convergence of work/leisure Swedish "IT University" with focus on telecommunications**	Transport: safety; unmanned vehicles, guidance/monitoring, high speed networks in trains, Intelligent maintenance; Home shopping, financial services, better information
Government/ public	Traffic management and road pricing; Embedded systems in vehicles; IT for lifelong learning; Electronic libraries; Education databases	Health, social security; Interactive information services; Transport telematics	Increasing Internet use	Lifelong learning; Health	Health statistics. Diagnostics; Environmental monitoring/modelling; Sustainable development indicators; Transport; Education; Use for participation		Health care (professionals); Transport (traffic management)	Education- access to resources; Virtual methods/processes; Government processes and decisions; Interactive debates; Focus groups

Table 7: Application Areas of IT in National Foresight Studies

4.1.3 Cross Cutting Issues

Cross cutting issues were mentioned in all studies except those of the Czech Republic, France or Spain due to the focus of the studies. The issues mentioned for Austria were derived from individual items in that country's Delphi Study.

The items finding most mention here were those high on the political agenda:

- Data protection and privacy – failure to address these issues could act as a barrier to the desired goal of active European participation in electronic commerce and more generally in the oncoming information society.
- The dependence of society on IST and its subsequent vulnerability to attack or failure has been highlighted at latest by the events of September 11 2001.
- Sustainable development is a major concern for all European countries, so that several have required their foresight studies to address this as an underlying issue. IST can play a variety of roles in this respect, e.g. monitoring, control of cleaner production, optimisation of resource use, environmental management etc., but also can have negative impact, e.g. through waste from obsolete technology.
- The exclusion of certain social groups from participation in the information society, in particular its benefits, is a major concern to politics, so education and training for IT use and also for IT related professions is high on agendas.
- In a more future-oriented vein, ambient computing is addressed in most studies.
- Another important aspect is the regulatory framework and various other policy measures which can foster or slow down the diffusion of IST. In this respect, it is seen as important to achieve a balance between citizens' interests related to data protection and privacy and the emergence of customer profiles and information as a kind of new currency.

Country Issue	Austria	Czech Republic	France	Germany	Hungary	Spain	Sweden	United Kingdom
Security/ Vulnerability				**Authentication Open source software**	**Creation of legal framework**	**Legal framework, security infrastructure**	**Vulnerability Mistrust Creation of network on security and privacy**	Integrity of Data Maintaining privacy Maintaining and handling large volumes of data Vulnerability of software "monoculture" (reverse side- monopoly)
Cohesion/ Exclusion	**IST applications for lifelong learning and support for elderly and disabled**				**Education for IS National awareness campaigns for IT**		**Lifelong learning**	
Sustainability/ Competitiveness	**IST applications for cleaner production and environmentally sound constructing and housing**				**Application of IT in environmental protection**	**IT in trade sectors**	**Better all-round utilization of natural resources**	
Ubiquitous/ Ambient computing	**High performance networks demanded; smart homes envisaged**				**High performance networks**			
Regulatory framework				Acceptance, ethics (IT applications in health)	Regulatory framework for IT (EU accession-oriented) ICT law			

Table 8: Cross-cutting issues related to IT in National Foresight Studies

4.2 Analysis of National Strengths and Weaknesses

The analysis of strengths, weaknesses, opportunities and threats (SWOT) practically belongs to the standard "toolbox" of foresight methodology. Such an analysis was done explicitly in a number of cases, although the results of the analysis have not been fully reported in publications resulting from the studies. In other cases, the analysis is more implicit and can only be deduced from recommendations, which frequently address strengths, but also weaknesses, for instance in recommendations related to the improvement of infrastructures, the legal system or the system of education. Information on the opportunities and threats identified in the studies is missing from virtually all of the studies, with the possible exception of the United Kingdom. Even here, it is contained in a report from a working group. It might well be that more detailed analyses are available in documents not readily available publicly, so that effort will be devoted to obtaining more information on such analyses from network members and other experts during the further course of the project. In particular, the Czech study indicates that there was a SWOT analysis, but none of its results are included in the document itself.

Some studies contained more general analyses of the country's economy, while others explicitly analysed the ICT sector (Spain, UK). Even in those countries where analysis was more general, IST aspects were a frequent concern, particularly computer literacy.

Austria

With regard to Austria, it should be emphasised in advance that there were criticisms, in particular from business representatives, regarding the minor role of IST played in Delphi Austria. The current situation of Austrian R&D partly deviates from that picture. The minor IST role in Delphi Austria was mainly a result of the preparatory studies. They were conducted to indicate fields of Austrian strength in order to concentrate on those fields in the Delphi questionnaire. Therefore, some of the preparatory studies can be seen as analyses of strengths and weaknesses:

- The analysis of the Japanese, German, French, British Delphi studies to separate and evaluate world-wide technology trends,
- A strength/weakness analysis of the Austrian competitive situation by both the secondary analysis of existing economic studies and a survey among 370 experts (39 % average response rate) to get a first impression of potential fields of success,

The secondary analysis of the foreign Delphis stated that IST are regarded as less important than one could expect from the public discussion. The technologies mentioned were (ITA 1998 Part 1, p. 44f.):

- Software is considered as important among the IST, in particular automatic protocol-based conversion technologies and test methods for fast and reliable programme development. Those software technologies, together with artificial intelligence, were expected in the next five years.
- Databases with adaptive elements, scientific-technical translation systems, and automatic retrieval from books are expected in the next decade.
- Highly selective sensors and interfacial engineering as well as intelligent micro systems on a single chip seemed likely to be realised in less than ten years.
- Among the nanotechnologies the studies evaluated, processing technologies were more important than materials.

– In telecommunication, protocols and conversion technologies were considered more important than the spread of digital broadband technologies.
– In services, tele-learning and tele-cooperation had the greatest interests of the experts.
– The implicitly most important trend was seen in achieving nearly unlimited broadcast capacity by improved fibre optic technology and by digitalisation of radio and TV broadcasting. This might have led to price decreases and possibilities in personal communication, remote sensing and monitoring and tele-medicine.

The survey among the 370 Austrian experts asked for the relative technological strengths and weaknesses of Austria both in science and in technology application. In science, Austrian strengths were firstly seen in environmental technologies and in materials as well as possibly in IST at lower levels. In technology applications, IST were not mentioned as a strength. The experts emphasised financial tightness, limits in funding, the political framework conditions and regulations as reasons for the unsatisfying technological position of Austria (ITA 1998 Part 1, p. 46f.). However, other studies attributed this position to lacking prioritising and organisational and educational deficits (Tichy 1997).

The strength/weakness analysis with the help of a secondary analysis of economic studies showed that Austria has improved her overall competitive situation, has even gained market shares in some fields of high technologies, has improved the quality of her exports and has increased active and passive direct investments. However, Austria has also some significant problems. She has competitive products mainly in fields of medium technological level and on regionally close markets, but she is not yet considered as an attractive location for high technologies and products for the world market. Instead of a stringent technology profile with specific advantages in a few products, Austria has a diversity of different products (ITA 1998 (1), p. 47). The authors deduced a need for priority-setting and qualification based on disaggregated analyses. Statistics of patent application showed a good position of electronics in absolute numbers, but a minor position relative to the number of employers and relative to the total number of patents in Austria and in Europe (ITA 1998 Part 1, p. 48). Regarding the ratio of high technologies to the total exports of goods, electronic parts had a ratio of 2 %, which was around the EU average. Other electronics, such as computer and business machines (1 %), consumer electronics (0.5 %) and telecommunications were below EU average (ITA 1998 Part 1, p. 49). Competition indicators stated that only television sets were competitive in the cluster ‘entertainment/leisure time’ (ITA 1998 Part 1, p. 49).

In Delphi Austria itself, IST were not treated as a separated thematic field in either the Technology Delphi or the Society and Culture Delphi due to a comparatively higher evaluation of other topics. For IST applications with an evaluation of a good chance of achieving Austrian leadership the simulation models to develop new processes and products were outstanding. A range of IST applications with R&D, economic and organisational potentials were envisaged in the fields education, work, production, mobility, medicine, ageing society, and material development. They are described in section 4.1. and listed in table 7 of this report.

Hungary

The Hungarian reports by the steering committee and the individual panels include no separate SWOT analysis, so it is necessary to analyse findings and recommendations for an implicit analysis. Again, the findings are mainly on the first two elements - strengths and weaknesses - while there is little on opportunities and threats.

The telecommunications industry had been successful up to the transition to the market economy, but was then faced with a loss of its established markets in Central and Eastern Europe. The companies active in this market ceased production and were either bought by new owners (IBM, Philips, Nokia, Ericsson) and/or changed their production profile. Thanks to greenfield investments by inward investors, the sector was again emerging as an "engine of the country's economy".

There was a strong knowledge and skills base for R&D on software and application-oriented org-ware which provided a basis for large companies to establish software development laboratories in Hungary (Siemens, Ericsson). Nokia was in the course of setting up its own research centre in Hungary for research on software products used in mobile telephony.

An opportunity was seen to reinforce Hungary's research capacities for software development for other industrial sectors. Motorola and the Academy of Sciences were, for instance, embarking on joint work on software quality control and applications.

Among the main weaknesses identified by the Hungarian foresight programme is a "low level of absorption capacity amongst people or the social readiness for new technology". Accordingly, the ICT panel's recommendations include the formulation of a new education strategy for the information society and the launch of national campaigns to "popularise the advantages and opportunities of the information society and to increase society's readiness for it."

This theme is varied several times in the recommendations, e.g. by particularly addressing psychological and mental aspects of the information society, information on potential opportunities offered by the information society etc.

Other weaknesses mentioned in a section on "where we are now" include allocation of resources, foreign investment and efficient utilisation of domestic capital. The state is still struggling to find its role under the new regime and the allocation of responsibilities between the various levels of government has not yet been finally determined. Ownership conditions in the agricultural system are also not yet settled, in particular government support is still not effective. Domestic supply is not yet able to fulfil domestic demand, meaning that Hungary at present relies heavily on imports.

While the system of unemployment benefits has prevented visible social conflict, "illicit" economy is very much on the rise. Budapest and Western Hungary have benefited most from the transition while Northern and Eastern Hungary have suffered.

Since there are recommendations to upgrade ICT infrastructures and to create an adequate legal framework for the development of the information society, the present situation would appear to represent a weakness.

Spain

After having carried out the three consecutive Spanish Foresight studies in field of IST, a mixed group elaborated on the findings identifying six major technological areas, the co-evolution of which will determine the development of the information society. Prosperity in these areas requires underlying technological capability. An attempt is made to define the Strengths and Weaknesses of Spain with respect to these capabilities as shown in table 9.

Technological Areas One to Six					
technological platforms			applications and services		Content
Internet	**Mobil communication**	**Ubiquitous computing**	**eBusiness**	**Applications and software**	**Content**
In Spain: due to insufficient deregulation, high costs, less user-friendliness and less technical quality of networks	financial situation of telecoms due to costs of UMTS licences difficult, and protesting citizens due to perceived health risks by emissions	ultimate end-users device not so clear; mix of PDA and mobile phone expected; convergence of TV and PC expected soon; "killer application" maybe location services short term; mid-term maybe wearables	exponential growth of e-commerce expected with B2B taking the lead; B2B requires complete integration and electronic markets; B2C in Spain comparatively low; perceived security and trust problem	trend towards middleware e.g. API, but Spain not advanced in this	revision of free content paradigm needed; Spanish content on Internet too low; some media markets threatended by global players of media industries.
Required technologies / **Position of Spain relative to EU**					
equipment and fixed line communication networks (routers, fiber, terminals etc.)	equipment and wireless communication networks (antennas, base stations etc.)	microelectronics (chips, memory, Bluetooth, WLAN etc.)	eCommerce solution and integrated business solutions (ERP, CRM etc.)	basic software (operating systems)	Protection and management of intellectual property (watermarking, DRM, etc.)
very low	**middle / low**	**very low**	**middle**	**very low**	**very low**
equipment and computer networks (server, fire walls, LAN etc.)	user equipment	periphery (optical memories, screens, keyboard, set-top boxes,	electronic payment systems	application software	payment systems (micropayment systems)
very low	**very low**	**very low**	**middle / high**	**middle**	**middle / low**
intelligent software; network administration software	network administration and security software;	reloadable batteries	security technology (PKI, encryption, SSL etc.)	software engineering	access devices (e-Books, set-top-boxes, game platforms,
middle	**middle**	**low**	**middle / high**	**middle**	**very low**
application software (browser, editors, agents, security etc.)	application software (APIs, WAP, location services)	application software and decoding	software solution for logistics and distribution (e-marketplaces)	----------	digital paper, digital ink
middle / high	**middle**	**middle**	**middle**	----------	**very low**
----------	----------	----------	----------	----------	software agents
----------	----------	----------	----------	----------	**middle**

Table 9: Six major technological areas (OPTI 2002b)

Strengths and weaknesses with respect to major trends have been presented systematically for OPTI 2000 and 2001. In these studies the position of Spain is compared explicitly with the one of the EU, although it is not stated on which basis this ranking has taken place. OPTI 1999 is less systematic in this respect. The information on strengths and weaknesses is more scattered and the positioning is not clearly related to other countries. As an aside it is worth highlighting that Network Computing is the only trend which all Spanish experts said would never happen.

time horizon	OPTI 1999 content industries	OPTI 2000 digital economy	OPTI 2001 convergence
to come true within 5 years from date of study	− widespread use of electronic information in professional contexts (till 2003) **favourable**	− development of B2B e-commerce **middle**	− geographical localisation services for users of mobile phones **favourable**
	− generalized use of e-mail for organizational communication (till 2003) **favourable**	− Use of digital signatures and certificates for Internet transactions **favourable**	− Bluetooth as standard for short distance data transmissions **not favourable**
	− widespread access of companies and organizations to the Internet (till 2003) **favourable**	− development of m-commerce **middle**	
to come true within 10 years from date of study	− extension of the Internet model by intranets and extranets for information, communication and transactions (till 2008) **favourable**	− development of B2C e-commerce **middle**	− broad deployment of UMTS **not favourable**
	− internet access in more than 50% of households (till 2008) **favourable**	− integration of e-commerce with other applications at company level **middle**	− implementation of Internet2 **not favourable**
	− B2B-eCommerce **favourable**	− overcoming the lack of qualified labour in the field of ICT **favourable**	− wide deployment of interactive TV **favourable**

Table 10: Strengths and weaknesses of Spain in the EU Context (OPTI)

Sweden

The Swedish foresight study includes a brief analysis of strengths and weaknesses in its final report. According to this Sweden has a number of strengths such as:

The education system which provides broad general education to a large number of people. Among its major assets are the good knowledge and experience possessed by many individu

als, good knowledge of English, experience in using computers and telecommunications, an interest in technology and a tradition of adult education.

The country's cultural strengths, include good industrial relations and a political tradition based on widely shared beliefs and values. Sweden also has more informal, less hierarchical structures and bureaucracy than many other countries. Public discourse is open and transparent, giving much weight to the younger generation.

The country has a long industrial tradition, including strong exports in many fields – iron and steel, timber/paper/pulp, engineering products, vehicles, telecommunications, defense, pharmaceuticals. This has turned Sweden into a successful user of new technology and Swedish industry into a prominent supplier of complex systems products. Sweden's environmental awareness and experience of modern technology make it possible to find domestic customers at an early stage for new, complex technology.

In proportion to its population, Sweden has an unusually large number of internationally active companies and organizations, in which comparatively many Swedes have gained solid experience of advanced international work (cf. The Foresighted Society, p.26ff).

More specifically in the IST area, Sweden's strengths are a solid industrial tradition, experience in systems thinking, a good knowledge of languages and the use of IT, a business culture suited to a project-oriented working method, and an infrastructure that is well-developed in many respects.

On the other hand, the Swedish foresight study also points out a number of weaknesses:

- A small domestic market, and a long distance from important markets and business partners;
- A lack of capacity for change in certain organisations and companies;
- Rigid regulations and structures for industry, in particular small companies;
- Comparatively high individual taxation making the country unattractive for skilled labour and acting as a barrier to higher education;
- Lack of ability to take advantage of the potential of women in the work force.

The Swedish Technology Foresight project primarily points to two fields in which both the government and the business sector can and must take quick action and make concrete decisions to develop Sweden's strengths and eliminate weaknesses: education and infrastructures.

There are a number of threats: a lack of desire for change in companies and public institutions, stiff competition from countries with low costs for both simple and highly educated labor, as well as a lack of interest in technology, industry and entrepreneurship among young people. Another threat is that research in production engineering and product development is being given inadequate resources.

United Kingdom

The SWOT analysis contained in the consultation document of the ITEC sub-group of the ICM panel is obviously provisional since the working group particularly invited parties having further information to make it available for the Foresight activity. The main results of the SWOT analysis are contained in the following table (Table 11). This seems to be the only genuine SWOT analysis, since it contains not only strengths and weaknesses, but also opportunities and threats.

Strengths	Weaknesses	Opportunities	Threats
Excellence in maths and physics	Insufficient translation of research into actual products and systems	Mobile services	Skill shortages (in the ITEC sector, computer literacy of the population, academic IT professions)
Strength in computer theory and software engineering	Inadequate "innovation culture"	Digital products	Need to import hardware
Strength in creative industries, such as content provision for information and entertainment, design skills, design of computer games		Non-volatile, low-power devices	Drainage of expertise
High quality research in photonics and opto-electronics		Graphic design in user interfaces	Lack of security and trust
Strong higher education sector		E-business, e-government	IT dependence (vulnerability)
		Providing digital content	Failure of sustainability
		Photonics and opto-electronics	
		Research support for grid computing and bio-informatics	

Table 11: Strengths and Weaknesses, Opportunities and Threats for the United Kingdom

Apart from attracting investment by the leading multi-nationals, the ITEC group sees opportunities mainly in niches, i.e. by choosing a few key long-term technologies "in which the UK could 'leap frog' volume producers of conventional products, and/or by "adopting and excelling in a particular role within global manufacturing where the UK can dominate a niche" (3.2.1).

On the subject of semi-conductors, the ITEC group report notes that multinationals have tended to draw more on the manufacturing-oriented skill base in parts of the UK rather than on "high-level R&D", although electronics multinationals were increasingly creating their own UK-based R&D facilities.

4.3 The Visionary Viewpoint

Depending on their context, aims and methods, the studies made very widely varying use of visions for the development of society or the information sector. Table 12 provides an overview of such visions:

Country	1. Societal Vision	2. IT Vision
Austria	Segmentation in all societal areas (i.e. work, housing, prevention, health, information, gender) The state retains control function, e.g. in environmental and education policy Increase in the importance of civil society by new forms of community activities Shifting of risk and responsibility from society to individuals Outsourcing of services from centralised institutions to decentralised networks Reduction of individual fundamental needs (work, education, housing) The demographic change affects the 'intergeneration agreement' ('Generationenvertrag') and constructing and housing The nation state retains importance as political actor, but is complemented by additional political levels, i.e. the regions and the European Union.	Nno significant R&D and economic strengths in hardware and software development and production were seen, but multiple IST applications within the fields education, work, production, mobility, medicine, ageing society, and material developments that lead to future potentials were envisaged New media is regarded to widen the gap between informed and less-informed people; Political discussions take place in electronic media
Czech Republic	Greater participation, democracy, market economy Increase in political radicalism and extremism(?) Ageing population Lifelong education, greater importance of science, more attempts to influence science	Export of know-how and software Hope to attract inward investors (production, software, technology centres Mobile communication already good, expected to increase importance Digital TV, e.g. as platform for health care, state administration
France		Warning against vision of "new economy" restricted to Internet. ISTs as powerful tool for human creativity Internet provides immense opportunity for coordination of economic activity and division of labour based on knowledge New form of cooperation contribute to acceleration of technological progress, especially in IT Firms, public institutions and infrastructure must adjust policies
Germany	Shift from what is possible to what is needed. Citizen participation in determining science priorities Lifelong learning Healthy and vital ageing population	Adaptation of networks and services to human needs. Reliable and permanently available IT infrastructure Comprehensive understanding of human information processing, cognition and creativity.
Hungary	Need to participate in global trends Need to offer mutually beneficial strategies to attract foreign partners. Lifelong learning, ability to process information, problem-solving skills etc.	Information society will also have losers IT and media as engines of economic development "Social readiness" for IS as major bottleneck Report contains three scenarios for IT sector.
Spain	Due to parallel panels working on their own with a low level of cross-sector synthesis of findings on the one hand, and the clear orientation towards the future of industrial sectors implied a low importance of societal visions.	In the non-ICT sectors the growing importance of ICT for monitoring, controlling, designing etc. is recognized; Scenarios of IST developments with respect to "digital content industries" have been developed assuming a growing importance of eContent and mobile eContent.
Sweden	"The Foresighted Society"	"An information society all" Report on IT contains 7 "visions": (1) always online, (2) digital assistant, (3) more and more is becoming software, (4) services of the future are electronic (5) continuous and immediate learning (6) the technological and biological worlds meet (7) security and privacy.
United Kingdom	Forward thinking society	Paper on IT visions with 15 scenarios, for areas of work, education and learning, leisure and entertainment, public infrastructure, health care, transport, e-commerce, government and public services. Overall vision "Let's Get Digital"

Table 12: Foresight and IT Visions in the National Foresight Studies

The visions emerging from this review are partly already known and more of the "catching up" or "keeping contact" type, such as the Czech, Hungarian, Austrian and Spanish "visions", while those from Germany, Sweden and the UK are more forward looking.

It is apparent that only five of the studies made visible use of scenario- or vision-like techniques. In greater detail these are as follows:

Germany

The "Futur" dialogue gives special attention to issues which are not the subject of a single scientific discipline, and thus extend beyond the reach of existing programmes for the support of disciplinary research. The results of this process, which runs through several well-defined stages are themselves clothed in individual "lead visions" or "Leitvisionen". The goal of the lead vision 'Living in the Networked World: Individual and Secure' is to resolve the conflict between man and machine. Electronic networks and their services must be adapted to the individual needs of the user and be permanently available everywhere as a reliable infrastructure.

A new, comprehensive approach uniting various experimental approaches, computer simulations and mathematical models is the research field of computational neuroscience, with which the lead vision "Understanding thought processes" is mainly concerned. Better knowledge of how the brain manages information processing, cognition and creativity would open up completely new approaches and chances for research and society. One example are more efficient teaching and learning strategies that could result from this knowledge. Another objective is to "learn from nature" to revolutionise technical information processing.

The lead vision "Creating Open Access to Tomorrow's World of Learning" envisages a society which is capable of learning and in which each individual is willing to continue learning throughout life. Each member of society has access to individual worlds of learning which are adapted to personal needs.

Finally, the "lead vision" "Healthy and Vital throughout Life by Prevention" is targeted towards ensuring health and vitality for an ageing population by means of health-conscious behaviour of each individual and through living conditions that promote health, at the same time increasing motivation for living preventively. The task for research and development is to create the conditions for efficient prevention in the future.

Hungary

The panel on information technology, telecommunications and the media developed three scenarios for Hungary in the Information Society:

The "small tiger" or active strategy: In this, Hungary is successful in creating the conditions to keep pace with global developments related to ICTs, playing a strong regional role in Central and Eastern Europe. Systems for information and communication provide many opportunities for social and economic innovation. A particular strength are the country's research and development activities in the field of telecommunications.

The "sparrow hawk" or defencelessly drifting strategy: In this scenario, Hungary is subject to strong foreign influence while the state remains largely passive and contributes little to the advancement of the ICT sector. The foreign influence is due to large international companies which continue to dominate the domestic Hungarian market. The state not only fails to provide support for local industry, but also makes little use of ICTs in providing public services or preserving the cultural heritage. While the well-educated labour force is able to find employment,

this is precarious and less educated people have few employment opportunities. Existing differences between regions in the country increase as the state fails to compensate for current imbalances.

The "dinosaur" or passive strategy: In this scenario, technological development in Hungary slows down, delaying or hampering convergence, the country is economically and politically isolated, the state plays only a weak role, failing to compensate for any gaps in development. Among the possible factors leading to such an overall development are unexpected difficulties in technological development, the "conservatism" of users, and even outright opposition to the information society.

As the scenarios developed for the other panels in Hungarian foresight, these scenarios were not harmonised with those of the steering group. From the recommendations, it is clear that the panel favours the first, most optimistic, scenario.

Spain

In the context of the Spanish Foresight Programme, scenarios of IST developments, especially of digital content industries have been developed by Francesc Mañà (Mañà 2000). The time horizon chosen is 2010.

The eContent market has a supply side with authors and intermediaries as the major types of actors, and on the demand side potential users are distinguished as techno-optimists or techno-pessimists. Techno-optimists are positive about new technologies and believe that these technologies can make their lives easier; techno-pessimists stay away from technology if possible and use them only in cases where alternatives are not available. This distinction leads to three scenarios called the "traditional" one, the "literati" one and the "mobile" one.

The "traditionalists" have no interest in technology and prefer paper-based information. Often they will be elderly people with difficulties to adopt new technologies, and there will be others with low income and/or education. Nevertheless it is assumed that via web TV at home and the PC at work new sources of information will be used gradually. They won't be too interested in e-commerce, i.e. obtaining paid information. What everybody would like to have seems to be especially important to stimulate this group: user-friendly devices and interfaces, trust, security and privacy.

The "literates" are introduced as those information oriented and willing to substitute bulky paper works by electronic information. They would use e-Books as well as digital paper if it would help them fulfil their tasks. Advances in end-user devices are important here. New technology must add value to convince this group. If technology and content are of good quality this group will pay for it. This group is open minded, middle aged or younger, with a higher income level and probably higher education. Their work is determined by use of huge amounts of documents.

The "mobiles" are characterized as people for whom "any time, anywhere" is especially important. End user devices like portables, mobile phones, and PDAs, and also later on wearable will be important for this group. The development of this scenario depends on the evolution of these devices and the development of volatile information needs (news, stock exchange, financial data etc.) where timeliness and speed are most important. Costs for UMTS will be more important than costs of devices. This scenario is particularly interesting for intermediaries. This should also be a market for transaction-based purchase of tickets, reservations, and shopping in general. Persons are imagined as young and middle aged in part, very positive about

new technologies which support mobility, and which at the same time have a high income. They will have higher education and their jobs require mobility.

Sweden

The final report on the first Swedish foresight project is ambitiously titled "The Foresighted Society", indicating a major vision for the impact of the foresight exercise. The panel on information and communications systems proposes a number of strategies, designed to enable Sweden to become a world leader in some areas and "thereby attract expertise and capital". The summary report contains a number of key technology areas described in a "vision-like" form:

1. *Always online:* People can communicate with each other independent of space and time, partially with the support of a personal communicator. Important aspects are home networks, wireless communications and convergence of media. It requires greater bandwidth and improved human-machine interfaces.
2. *The Digital Assistant:* Software is available to independently examine and interpret information for the individual. This requires the appropriate standards, sensors and improved techniques for the retrieval, interpretation and evaluation of data.
3. *More and more is becoming software:* Many functions of hardware can be replaced by software. This sets new demands for software production tools, programming, packaging, distribution and recycling of software.
4. *Services of the future are electronic:* Traffic both in electronic and physical products and services enabled by electronic means is increasing (e-commerce), leading to new business models and an increase in the value of customer information and brand names. Needs identified here are greater bandwidth, new standards, payment systems and delivery and quality control.
5. *Continuous and immediate learning:* There will be more connections between work and learning as well as entertainment and learning. To achieve a breakthrough in this field, there must be efforts on development of teaching methods, software tools, functional interfaces and greater bandwidth.
6. *The technological and biological worlds meet:* This refers both to applications of IT in biotechnology, but also to the development of IT from biological knowledge. The miniaturisation of electronics is a major driving force, and additional developments include biological sensors and interfaces. A challenge for more basic research is the use of biomolecules as electronic materials.
7. *Security and privacy:* There are threats to privacy and society is vulnerable due to its dependence on IT. There is a need to foster trust to enable greater diffusion of IT applications. Beside technological solutions, this requires work in the legal/regulatory field.

For several years already, the Swedish government has been running a programme on "An Information Society For All", which is driven by the goal of making the country the first to be such an information society with universal participation. The programme is targeted on three main objectives: *confidence* in IT, *competence* in IT application and *accessibility* to the services of the information society. Swedish authorities proudly underline that Swedish society has been ranked first of all countries in terms of "e-readiness", i.e. readiness for the information society.

The United Kingdom

One of the sub-groups of the panel on Information, Communications and Media was on Information Technologies, Electronics and Communications (the ITEC Group). This produced a number of documents including one on IT visions. These are described as "fairly informal

glimpses of the possible future" for seven broad, sometimes overlapping, themes: work, leisure, learning, health, transport, public administration and use of the Internet. Each vision is contained in one or more narrative, describing the way IT was likely to have impact in these areas. There are 15 of these narratives in all. The individual technologies, expected benefits and issues requiring resolution underpinning the narratives are shown in Table 13, subdivided by application area.

Area	Functions	Perceived Benefits	Issues
Work	Universal high bandwidth connectivity Powerful portable PCs Radio/mobile networking Reliable and flexible software components Cheap on-line computing services	"Remote" working for knowledge workers Reduction of commuter journeys Powerful, "pocket-size" databases less dependence on corporate IT Automatic data exchange improved suppler-customer relations Adaptability to new models and/or best practice Simplifies regulatory compliance/best practice easy	When to work at home/workplace/third-party sites Balance between work, leisure, training domestic life Maintenance of data integrity Maintaining privacy Handling large volumes of transaction data Monoculture: dependence and vulnerability Danger of over-regulation; validation of source mat.
Education and learning	Universal high bandwidth connectivity Access to worldwide resources Virtual training methods/processes Use of Internet for research and scholarship Changes in educational administration Growth of new cultures "on-line"	Remote multimedia learning; independence of time and space "Best" available to all Choice possible; development of individual learning profiles; variety of setting and methods possible International teams; access to mass data Point to point learning possible; educational establishments less important; world student market Emergence of new social structures/relationships	When to learn at home/work/institution Balance between learning, work and leisure Loss of diversity; Quality hallmarks needed. Individuals responsible for choice; social education must be included Changes in publishing; methods for evaluation Public/private distinction blurring; major players might dominate, physical institutions endangered Intangible benefits of education endangered
Leisure and entertainment	High-quality virtual reality at "domestic" prices Very high bandwidth universal network Advanced video games, graphics, 3-D displays Better consumer access to GPS, mobile computing, mobile data etc. Advanced domestic appliances Spread of interactive games and pastimes	Enabling remote versions of many experiences Access to multi-media material from anywhere Improved human-machine interfaces Leisure pursuits enhanced, increased safety of challenging sports "Smart homes" organised automatically More entertainment facilities for individuals	Addiction to VR; devaluation of "real thing" Digital rights management; filtering undesirable content Exploiting UK's excellence in graphic arts Use of IT in traditional pursuits; should extreme sports be encouraged by safety features? Time reduction for undesired domestic duties Threat to communal activities
Health Care	Remote diagnosis Human/non-human intervention or advice Body monitoring	Healthy, long life Speed of service Fewer lost working days	Confidentiality Cost, impact on taxes Hypochondria
Transport	Safety critical systems Unmanned vehicles Guidance systems and monitoring High speed networks in trains Intelligent systems for repair and reconfiguration	Fuel efficiency Enhanced connectivity to information Reduced congestion Enhanced safety and reliability	Connection of vehicle to external networks Impact of telepresence on need to travel Impact of home working
E-commerce	Home shopping Home banking and financial services Virtual experiences Portable access to information	Cashless society Choice Accessibility Personalisation of content through agents	Reduced need to travel Impact on high street shops Confidentiality and security Impact on social interaction
Government/public administration	Access to government processes and decisions Interactive debate Focus groups	Influence on decision making processes Freedom of information Increased breadth of democratic process	Is democracy enhanced? Confidentiality Spin doctoring and/or brain washing

Table 13: Visions in the UK ITEC Sub-Group (adapted from: *ICM Panel: ITEC Visions*, London, DTI: June 2000)

5 Conclusions and Lessons

About realistic expectations

First, the needs of the countries, and the aims of the exercises covered in the sample of eight varied greatly, so that comparison of their approaches and methods is of limited value and it is certainly not the aim of workpackage 1 to analyse the merits or demerits of the studies.

Second, the effort and resources devoted to foresight varied a great deal from one country to the next. In addition the amount and quality of information available also varied greatly. This was due in part to language – in some countries only the most important reports have been translated into English -, in part to publication policies – in one country there were over 100 reports, while in another there is only a single final report -, and in part to recentness – more has been written by participants on exercises completed further in the past than on those whose results have only recently been published. Vastly different numbers of publications on the exercises have been produced from one country to the next. The amount and quality of information on the results of the foresight studies on IST also vary, so that mention of results from one country does not necessarily imply that the results from another are any less valid. In some cases, the process leading up to a finding or recommendation is simply not (yet) transparent.

Third, as review and analysis of completed technology foresight is by definition a kind of "foresight hindsight", it is highly unlikely that the analysis will provide new or surprising insights into future IST developments.

However the synthesis of IST findings as presented in this report can provide baseline information to be employed in new IST foresight activities in view of the European Research Area (ERA). A major benefit of this current exercise is the aggregation of information on experience with foresight methods on IST, its systematization and its availability as a public source of information. It can be the basis to attract more information, and it is to be hoped that more, including first-hand accounts of actors intimately involved in the studies, will be forthcoming from FISTERA network members and other major actors as the project progresses.

IST foresight shortfalls

In addition to general limitations due to the methods chosen, the shortage of time or lack of cohesion between the individual elements, there are some typical limitations, which might be read as caveats for further foresight exercises on IST.

– While IST were regarded at least implicitly as "underpinning technologies" in most studies, there was in no case a single body, such as the steering group or a panel, to synthesise findings on IST.

– Research at the cutting edge of IST was seldom addressed due to the very application-oriented nature of most foresight studies. One past foresight programme had been accused of having disadvantaged more basic "blue skies" research. However, the "cutting-edge" areas of research are well-known through studies of the key technologies type.

– The time horizon employed for foresight studies is ostensibly quite long, usually between 10 and 25 years. In the case of IST this is sometimes shortened, due to the very dynamic nature of this area. Even so, it is very difficult for participants in foresight exercises to avoid falling victim to what the Swedish Foresight Study terms as "Zeitgeist", i.e. mainly

extrapolating the present situation and assuming that today's problems and technologies will also be those of the medium- to long-term future. As a result, the recommendations and findings are oriented mainly towards short-term policies.

– Another problem of most studies is their failure to truly investigate alternative developments or the possibility of unexpected events ("wild cards"), such as unexpected technological breakthroughs or disrupters (such as the creation of artificial intelligence superior to human intelligence, or more modestly effective machine translation systems) or technology related catastrophes (a new year 2K problem or a collapse of the banking IT infrastructure). Other uncertainties are political developments, such as the further development of the European Union.

The major caveats for IST foresight to be taken into account are (1) to take care of integrating results of different panels etc., (2) to keep application orientation without loosing sight of cutting edge research, (3) to methodologically control the "Zeitgeist" and the "time-horizon" problem in rapidly changing fields, and to think in alternatives instead of linear forecast projections.

National orientation, but underlying European concerns

The studies selected for the first phase of the FISTERA project were all national-level foresight exercises. A common goal for most studies was to contribute towards research priority setting and towards improving the uptake of the results of publicly funded research and development by domestic industry. In this sense, the focus was on the innovation systems of the individual countries and only to a minor extent on Europe or specifically the European Union.

– A goal of the foresight studies which seems to have gained importance over time was the **creation of networks** among the actors involved in technological development and application. Other objectives in a similar vein include awareness raising, the implementation of new methods of governance of science and technology.

– The major visions underlying the studies with respect to IST were very similar and more or less **in line with the Lisbon objectives**: Internet uptake, the Information Society for all etc.

– Most studies underlined existing IST trends, such as mobile telephony, opportunities in the development of human-machine interfaces. **Awareness of the specific needs** and the development of interfaces and software to meet the needs of specific groups is perhaps more intensive in Europe than elsewhere in the world due to the vast diversity of cultures and traditions, and to the small size of each regional market. If smaller countries, or even regions, are to participate in full in the oncoming information society, they must adapt existing technology to their own needs. Doing so sharpens awareness of the importance of the factors involved and possibly helps to develop skills which can be put to advantage in other countries.

– The major application areas for IST were at the same time usually those high on the political agenda for other reasons, e.g. **health care** and **applications for the elderly**. Health insurance and health care systems in many EU member states are faced with a crisis, in which IST can offer partial solutions. In addition, populations in almost all European countries are ageing, drawing attention to potential use of IST in retaining independence of

the elderly, and also to the need to design IST specifically for older users. Other examples are **transport**, **government and governance**, the **environment**. The cross-cutting issues addressed in the studies are also usually those with high priority for political decision-makers, e.g. privacy and vulnerability, sustainable development, education etc. In such cases, urgent needs might again produce solutions that can be applied, and thus marketed, elsewhere.

– Major worries are expressed in several foresight studies concerning the danger of **loss of qualified experts** on the cutting edge areas of science to other countries, either in Europe (for the accession countries) or elsewhere (e.g. Germany, the UK). One of the reasons for this threatened "brain drain" is a shortage of students in the field world-wide, and so **education for IST professions** is an item high on the agenda of the foresight studies.

The important finding is that despite the uniqueness of each exercise and its national orientation, there are common concerns, which could probably be addressed better in a co-operative way at the European level.

Suggestions for European IST Foresight

From the review of the national foresight exercises suggestions have been derived for foresight efforts which require European cooperation to be successful.

– The European dimension is most clearly present in SWOT analyses as part of the national foresight exercises, although usually not very systematically. A task of EU level foresight could be a EU-level SWOT analysis. The national SWOT analyses could provide information to formulate hypotheses for such an analysis, but the analysis itself would have to draw on other sources of information. This dimension is already recognized by FISTERA aiming at mapping areas of particular scientific expertise and potential areas for collaboration.

– An option for European level foresight is a uniform exercise of the "Technologie Clés" type across all or several countries. This would include assessments of the relative positions of each country and Europe at a global scale for individual technologies or applications.

– Another task for European foresight studies could be to explore applications of "cutting edge" technologies envisaged by various actors within predetermined time-frames. Studies of this type are faced with problems of suitable design. One problem facing investigators in this area is a variant of the well-known "Collingridge Dilemma", namely lack of precise information on potential etc. at early stages of development and lack of alternatives and options at the later stages.

– A very helpful feature of the Swedish study was the "technology hindsight" study, which can contribute to improving the techniques used for forecasting technologies important in the future. Its subject were mainly technologies which had so far failed to fulfil their early promise, but it would also be useful to extend the approach to such technologies whose success (!) had not been predicted, the most recent examples being the Internet and GSM mobile telephony.

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List of Abbreviations

API	Application Programming Interface
B2B	Business to Business
B2C	Business to Consumer
CAD	Computer Aided Design
CR	Czech Republic
CRM	Consumer Relationship Management
DNA	Deoxyribonucleic Acid
DRM	Digital Rights Management
DVD	Digital Versatile Disc
EITO	European Information Technology Observatory
ERA	European Research Area
ERP	Enterprise Resource Planning
ESTO	European Science and Technology Observatory (network)
ETAN	European Technology Assessment Network
EU	European Union
Eurostat	Statistical Office of the European Communities
FISTERA	Foresight on Information Society Technologies in the European Research Area
FP	Framework Programme
GBAORD	Government budget appropriation on R & D
GERD	Gross Domestic Expenditure on Research and Development
GDP	Gross Domestic Product
GIS	Geographical Information System
GPS	Geographical Positioning System
ICM	Information, Communications and Media
ICT	Information and Communication Technology /Technologies
IST	Information Society Technology /Technologies
ISTAG	Information Society Technologies Advisory Group
ITA	Institute for Technology Assessment at the Austrian Academy of Sciences
ITEC	Information Technology, Electronics and Communications
IT	Information Technology
NGO	Non-governmental Organisation
NIS	National Innovation System
NSI	National System of Innovation
OECD	Organisation for Economic Cooperation and Development
OPTI	Observatorio de Prospectiva Tecnológica Industrial (Industrial Observatory of Technological Foresight)
PDA	Personal Digital Assistant
PKI	Public Key Infrastructure
R&D	Research and Development
S&T	Science and Technology
SME	Small and Medium Sized Enterprise
SSL	Secure Sockets Layer
STRATA	Strategic Analysis of Specific Political Issues
SWOT	Analysis of Strengths, Weaknesses, Opportunities and Threats
UK	United Kingdom of Great Britain and Northern Ireland
UMTS	Universal Mobile Telecommunications System
VR	Virtual Reality
WAP	Wireless Application Protocol
WLAN	Wireless Local-Area Network
WP	Work package

Annex 1: Characteristics of Foresight Exercises

"Delphi Austria", 1996 to 1998 / Austria		
Categories, Criteria & Questions	**Answers**	**Comments**
Project promoter / initiator	– Austrian Federal Ministry of Science and Transport	– The former Ministry of Science and Transport is now the Ministry of Education, Science and Culture and the Ministry of Transport, Innovation and Technology
Agency or organization responsible for the foresight activity	– Institute of Technology Assessment, Institute of Trend Analysis and science journalist Holger Rust	
Scope / areas covered	– 10 thematic fields, 4 of them overlapped in Technology Delphi and Society and Culture Delphi	
Time horizon	– in general 15 years, additionally 5 and 30 years in Society and Culture Delphi	
Societal dimension	– extensive inclusion of societal trends and aspects	
European dimension	– not explicitly, but mentioned at several points	
Major explicit objectives	– to identify innovation potentials and niches within technology trends and possibilities for Austrian leadership within the next 15 years	– the identification mainly took place in the field selection and the statement formulation – subsequent Delphi steps verified or falsified selected trends and possibilities
Second order objectives and indirect effects	– to improve anticipatory intelligence – to use results for determining priorities and direction setting – to take into account the broader societal context of technological innovation	– involvement and networking of participants was seen as positive impact in itself
Impact	– self-assessed broad impact on formulation of research programmes and on establishment of Competence Centres, stimulation of cluster building and triggering further 'foresight' studies	– involvement and networking of participants as positive impact in itself
Target groups	– decision makers in policy and business as well as the general public	
Participation	– experts selected from science, business, NGO etc. for each thematic fields: around 240 in active roles, around 8000 addressed by questionnaire, around 2,200 answers analysed	– criticism of closed groups
Major Characteristics	– combination of Technology Delphi with Society and Culture Delphi, – broad definition of 'expert' – primarily designed as a Decision Delphi – high 'degree of finalisation', especially of policy recommendations	

Methodology	– preparatory studies – expert panels for preparing and analysing questionnaire – Technology Delphi and Society and Culture Delphi with 2 rounds each – integrative analysis for overlapping fields	– Delphi Austria was regarded as an example of an advanced and broad Delphi approach – criticism of modest innovation level due to lack of time for preparing the questions, lack of interaction (no "pre-Delphi" seminars or workshops were done), and problem of closed groups
In which way have IST been included and treated in the FS exercise?	– IST not considered in a separate thematic field, but as cross-cutting technology in many IST applications in nearly every thematic field	– criticism of neglecting IST formulated by business representatives
Strengths/opportunities weaknesses/threats identified in IST	– in general no strength in the production and development of IST (specific hardware or software) was seen, but potentials for leadership in several IST applications	– most promising IST applications in simulation – most impulses for IST developments in the field 'medicine' – overall modest innovation level of considered IST applications – IST consideration depending on initial selection
Dissemination	– reports published in several forms, also made available at Ministry's Website, workshops, conferences, several secondary analyses	– most secondary analyses were conducted by the organisers themselves – criticism of sub-optimal dissemination to business

Foresight effort "Technology Foresight 2002" Czech Republic		
Categories, Criteria & Questions	**Answers**	**Comments**
Project promoter / initiator	– Ministry of Education, Youth and Sport/Research and development Council of the Czech Government	
Agency or organization responsible for the foresight activity	– Technology Centre, Czech Academy of the Sciences/Engineering Academy of CR	
Scope / areas covered	– 14 thematic panels, 3 cross-cutting, proposal for management and implementation of National Research Programme	
Time horizon	– 10 years	
Societal dimension	– "social transformation", information society	
European dimension	– not explicit, but impact of joining EU, integration of transport and education systems, "brain drain" to other EU countries; integration of R&D in ERA	
Major explicit objectives	– draft proposal for National Research Programme	
Second order objectives and indirect effects	– "networking"	
Impact	– used for National Research Programme	
Target groups	– Government	
Participation	– c. 300 experts plus further interviews of managers responsible for R&D strategies	
Major Characteristics	– 5 meetings per panel – studies by external experts – interviews – SWOT analysis (but results not included in final report	
Methodology	–	
In which way have IST been included and treated in the FS exercise?	– panel on the "information society" – some mention of IST in work of other panels	
Strengths/opportunities weaknesses/threats identified in IST	– not explicit – threat of "brain drain" to other countries	
Dissemination	– website, CD-ROM (in English also) – final conference	

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 sub-groups, 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.	

Foresight effort "FUTUR" year 2001/2002 / Germany		
Categories, Criteria & Questions	**Answers**	**Comments**
Project promoter / initiator	– Federal Ministry of Education and Research (BMBF)	
Agency or organization responsible for the foresight activity	– IFOK (Institute for Organisational Communication), Bensheim / Berlin and subcontractors: ISI (Fraunhofer Institute for Systems and Innovation Research), Karlsruhe, IZT (Institute for Future Studies and Technology Assessment), Berlin, VDI / VDE-IT (Technology Centre Information Technology), Berlin, Science & Media, Pixelpark AG, Köln	
Scope / areas covered	– to formulate visions for programmes operated by the research ministry. No predefined boundaries of scope	
Time horizon	– not exactly specified (about 2020)	
Societal dimension	– strong orientation towards societal goals, for instance solving a pressing problem of society, connection of the needs of the society with technological and social innovation	
European dimension	– not explicit, rare importance	
Major explicit objectives	– influence priority setting of federal research programme – with a high degree of complexity and interdisciplinarity – oriented on societal demands – support comprehensibility	
Second order objectives and indirect effects	– support and evaluate a participatory approach	
Impact	– to further priority setting and development of research programmes by the Federal Ministry of Education and Research (BMBF)	
Target groups	– Federal Ministry of Education and Research	
Participation	– representative for all members of society, one third from science, industry and society, with special attention to SME, young scientist, women and artists.	
Major Characteristics	– selective reduction of items until the formulation of 4 lead visions	
Methodology	– open dialogue with experts and citizens – televoting over research priorities via Web – workshops – focus groups – future scenarios	
In which way have IST been included and treated in the FS exercise?	– no special attention was given to IST. IST is integrated in the formulation of the overall research lead visions.	
Strengths/opportunities weaknesses/threats identified in IST	– no special attention was given to this question	
Dissemination	– special attention is given to understandable information for the public via a Newsletter, the Web, conferences and road shows	

Foresight effort: Hungarian Foresight Programme (TEP) 1997-1999/Hungary		
Categories, Criteria & Questions	**Answers**	**Comments**
Project promoter / initiator	– National Committee for Technological Development (OMFB)	
Agency or organization responsible for the foresight activity	– OMFB	
Scope / areas covered	– 7 (later 8) thematic panels	
Time horizon	– 15 to 25 years	
Societal dimension	– goals include economic prosperity and improvements in quality of life – some panels organised around "social functions" (e.g. health, transport)	
European dimension	– impact of member ship of EU	
Major explicit objectives	– contribute to selection of long-term research goals and priorities – consensus-building – transparency on application of key technologies	
Second order objectives and indirect effects	– decision-making in interdisciplinary areas – promoting dialogue between stakeholders – generating alternative visions	
Impact	– some recommendations discussed favourably by parliamentary committees – some recommendations incorporated in policy documents – creation of networks among participants	
Target groups	– Ministries, NGOs, Industry, "the state", "market participants", "society"	
Participation	– c. 150 panel members, up to 1400 participants in Delphi survey	
Major Characteristics	– sector oriented foresight – fairly autonomous panels	
Methodology	– 2 round Delphi, scenario building, panels, pre-foresight including "awareness raising" events involving chambers of commerce, professional associations	
In which way have IST been included and treated in the FS exercise?	– expert panel on IT, telecommunications and the media; also subject of several other panels; steering group picked up IST in several recommendations	
Strengths/opportunities weaknesses/threats identified in IST	– loss of established telecommunications market – strength in software development (application software, org-ware) – low level of IT readiness of population – unsuitable laws, regulations – IT infrastructure poor	
– Dissemination	– report on website (also in English), some documentation – many regional seminars	–

Spanish Foresight Programme (OPTI) 1998-2001 / Spain		
Categories, Criteria & Questions	**Answers**	**Comments**
Project promoter / initiator	– Ministry of Industry; and Ministry of Science and Technology as follow up	– The ministry of industry has been changed to the one of Science and Technology
Agency or organization responsible for the foresight activity	– OPTI = Observatorio de Prospectiva Tecnológica Industrial Fundación – Coordinator EOI = School of industrial organisation – 8 Technology centres responsible for a given sector	– OPTI was founded in 1997; in 1999 it adopted legal status of a foundation; despite this status the link to the Ministry remains very strong with a state secretary being its president. – EOI coordinated the 1999 and 2000 studies, not the last one.
Scope / areas covered	– meso / eight industrial sectors	– "The Ministry of Energy and Industry wanted elements to define its policies and to support decision making in companies" (ESTO 2001)
Time horizon	– 15 years	– despite this time horizon most respondents seem to have had the short term future in mind
Societal dimension	– the sectoral approach includes social questions like employment, competitiveness etc.	– basically we deal with technology foresight aiming at S+T policy priority setting
European dimension	– R&D policy is aware of European programmes and funds – within the work of panels and the Delphi surveys the European dimension is hardly present – ICT SWOT carried out later with reference to position within EU	
Major explicit objectives	– strengthening the Spanish innovation system – priority setting in innovation and R+D policy – informing industries about promising technologies in the medium and long term – search for industrial competitiveness – orientation of research centers	– questions: What technologies should the Government administration support ? – what should industries concentrate on? – where should they invest?
Second order objectives and indirect effects	– new communication patterns between policy and industry; – catch up with EU practices – awareness of future technology trends within industry sectors	– benefits of "the process" ; maybe second order legitimation
Impact	– support to the preparation of the National R&D Plan and Spanish position in EC FP6. Guidance for industrial associations & private companies – raising awareness; Helping private & public sectors in future thinking, support to the innovation plans of R&T Centres	– role of establishing an new type of National Innovation System
Target groups	– decision makers in industries and policy	
Participation	– c. 6000 experts, stakeholders	– experts only; some say there was not enough long-term knowledge, and not enough social knowledge involved
Major Characteristics	– industrial foresight – sector oriented foresight	

	– decentralized – institutionalised, permanent foresight agency allowing for post-processing – investigating also traditional sectors	
Methodology	– expert panels – two round Delphi – scenario building – desk research	– three consecutive Delphi surveys in each industry sector with a shifting focus
In which way have IST been included and treated in the FS exercise?	– there was a special organisation and a corresponding panel carrying out the three ICT Delphis – ICT was also considered in other panels	– findings of the ICT panel and findings of the other panels about iCT were not brought together in a systematic way
Strengths/opportunities weaknesses/threats identified in IST	– application software in general and epayments, and security applications in particular look promising – in the fields of hardware, network technology, basic software competitiveness appears to be weak	– location services as well as e-commerce look promising; hurdles are lack of deregulation, 3G licensing debts, free content culture; not enough Spanish content on the web.
Dissemination	– for each year's activity a report has been published – there are seven special bulletins reports written after publication of the main studies, which summarize the findings and identify major trends in the sector and associated technologies – there is also a quarterly news bulletin which contains synthesis information and scenarios – OPTI has its own website with the information freely available – OPTI publishes an OPTI bulletin, and – a trimester bulletin derived from the cooperation with the Patent Office presenting results of technology watch in two sectors. – An international conference 2001; national & regional workshops – Media campaign	– the 26 Delphi surveys and the reports are not publicly available – one of relevance for FISTERA is devoted to ICT (Tecnologías de la Información y la Comunicación. Tendencias tecnológicas a medio y largo plazo) – one of these bulletins is on “Possible Scenarios for the Digital Contents Industries” (Posibles escenarios para las industrias de contenidos digitales Estudios de prospectiva 2000-2001) – literature talks also of a special "summary document" requested by the ministry and the publication of books. It is not clear if these documents have been published and if they are separate publications – ESTO 2000: “… Foresight awareness has clearly increased, with the Foresight conference on 16th-17th – October 2001 receiving about 200 participants, a level of interest that would have been difficult to imagine just three years ago.”

Foresight effort "The Foresighted Society" 1998 - 2000/Sweden		
Categories, Criteria & Questions	**Answers**	**Comments**
Project promoter / initiator	– Royal Swedish Academy of engineering – Swedish National Board for Industrial and technological Development – Swedish Foundation for Strategic Research – Federation of Swedish Industries	
Agency or organization responsible for the foresight activity	– Swedish Royal Academy of Engineering – Swedish National Board for Industrial and Technological Development (NUTEK)	
Scope / areas covered	– 8 panels on the basis of user perspectives	
Time horizon	– 10 to 20 years	
Societal dimension	– "user perspective" of panels	
European dimension	– EU membership is "outside pressure" on market – domestic market no longer Sweden but EU	
Major explicit objectives	– strengthen futures-oriented approach in companies and organisations – identify areas of expertise with potential for growth and renewal in Sweden – compile information and design processes for identifying high-priority areas in which Sweden should build expertise	
Second order objectives and indirect effects	– commitment of private companies, public agencies and other interested parties to the foresight process.	
Impact	– most recommendations picked up by government – long term character appreciated by industry	
Target groups	– industry, public agencies	
Participation	– advisory panel recruited from c. 30 organisations – 130 panel members	
Major Characteristics	– non-governmental foresight organised by important organisations and agencies	
Methodology	– panel discussion, brainstorming, some use of scenario techniques, but variable from one panel to the next – technology hindsight as unique feature	
In which way have IST been included and treated in the FS exercise?	– panel on information and communication systems, but IT is also treated as a pioneering technology. IT is also addressed in the work of most of the seven other panels	
Strengths/opportunities weaknesses/threats identified in IST	– good education system – informal structures with low degree of bureaucracy, but also tendency to resist change in some companies – language Skills (English – solid industrial tradition – experience in systems thinking – project-oriented working methods	

	– small domestic market, long distances to important foreign markets – rigid regulations and structures as barrier to SMEs – high individual taxation, low pay for academics – temptation to emigrate – competition from countries with lower labour costs – lack of interest from young people in S&T jobs – inadequate resources for R&D on production engineering, product development	
Dissemination	– final conference, Report on website and published physically – many workshops to disseminate and discuss results – 20 regional conferences over 100 presentations for specific organisations or companies	

Foresight effort Second Foresight Cycle 1999-2002/ United Kingdom		
Categories, Criteria & Questions	**Answers**	**Comments**
Project promoter / initiator	– Department of Trade and Industry, Office of Science and Technology	– DTI is responsible for science in UK
Agency or organization responsible for the foresight activity	– Office of Science and Technology	
Scope / areas covered	– 10 sectoral panels – three thematic panels (ageing, crime prevention, manufacturing) – two underpinning themes(Sustainable development, education, skills, training) – over 30 “associate” programmes	– supply-chain based approach, oriented towards applications in contrast to first cycle, which was focused on areas of technology
Time horizon	– 15 to 20 years	
Societal dimension	– Supply-chain based approach	
European dimension	– pro-active involvement of UK in shaping EU policy and regulation – foresight results to inform UK participation in FPs – GRID computing as major area for European cooperation – UK seeks to influence EU through people in strategic positions – partnerships and alliances	
Major explicit objectives	– increase UK exploitation of science. Identify potential opportunities for the economy or society from new science and technologies, consider how future science and technologies could address key future challenges for society. – build and strengthen networks – wealth creation, improved quality of life	– goals as stated on website
Second order objectives and indirect effects	– creation of “foresight culture” – future oriented thinking among actors in S&T	– grew in importance as exercise progressed
Impact	– second cycle stopped in 2002 – “Link” project selection influenced heavily by foresight – Young Foresight programme – regional foresights	
Target groups	– Ministries – Research councils – industry – “intermediary” organisations (e.g. trade associations) – “society” as a whole	special efforts to target SMEs
Participation	– 160 workshops and seminars – website with reports, consultation documents (46,500 visitors monthly average) – over 500 participants in panels and task forces	
Major Characteristics	– successor to first cycle incorporating changes due to consultation	Delphi survey abandoned from first cycle to second

	– main work in panels and task forces – associate programmes run by associations etc. – "knowledge pool" as common support tool	
Methodology	– main work in panels/task forces with production of reports after one year. – 160 workshops and seminars – 52 regional seminars – consultation phase for comments/revisions to reports – active dissemination policy	
In which way have IST been included and treated in the FS exercise?	– "underpinning" technology with two members in each panel responsible for giving attention to IST – separate panel on Information, communications and the media – task groups on Information technology, electronics and communications, learning in 2020, information relationships in ICM panel – further task forces, e.g. On e-commerce, IT in crime prevention etc.	
Strengths/opportunities weaknesses/threats identified in IST	Strengths: – excellence in maths/physics – strength in computer theory/software engineering – creative industries (content provision, information, design skills – high quality research in photonics/optoelectronics – strong higher education sector Weaknesses: – insufficient translation of research into practice – inadequate "innovation culture" Opportunities: – mobile services – digital products – non-volatile, low-power devices – graphic design of user interfaces – e-business, e-government – digital content provision – photonics, opto-electronics – grid computing, bio-informatics Threats: – skill shortages – dependence on hardware imports – drainage of expertise – lack of security and trust – IT dependence – failure of sustainability	
Dissemination	– over 100 reports published – all reports available on web – seminars, workshops	

Annex 2: Case Studies[1]

A2.1 Austria – Delphi Austria

A2.1.1 Summary

This was a combined technological/socio-cultural Delphi with each subdivided further into 7 fields. The exercise ran from 1996 to 1998, employing a standard time horizon of 15 years. The society and culture Delphi also examined five and thirty year periods. The aim of the study was "to identify Austrian strength in R&D with sustained future potential". The exercise employed the standard Delphi method with panels and a survey. A total of about 250 experts was involved in the panels with around 3,200 experts responding in the Delphi surveys. The Austrian example was chosen due to its broad inclusion of societal aspects.

A2.1.2 Background and Objectives

Since the early 1970s, after reaching a high-income stage, Austria could no longer increase productivity and wealth by importing technology and was compelled to develop her own technology policy, R&D, and foresight activities. Since the early 1980s, a more systematic and target-oriented policy was introduced, starting by launching programmes to support 'future technologies' (e.g. micro electronics, new materials, or computer-integrated manufacturing) without foresight exercises. In the late 1990s, a more specific 'National System of Innovation' (NSI) based upon a national foresight programme was regarded as needed and the Delphi Report Austria was commissioned.

Delphi Austria was initiated by the Austrian Federal Ministry of Science and Transport in 1996 and it was concluded in 1998 with the publication of the final reports (ITA 1998, ITK 1998). The budget was around 700,000 US-Dollars. Due to the specific Austrian situation - to concentrate and to search for research priorities - the objective of Delphi Austria was not to detect emerging technologies but to identify innovation potentials and niches within technology trends and possibilities for Austrian leadership within the next 15 years. Delphi Austria was envisaged to strengthen Austrian long-term competitiveness. A social problem-orientation was chosen with the underlying assumption that innovations solving existing real-world problems will find a market more easily.

A2.1.3 Organisation of the Foresight Exercise

The main feature of Delphi Austria is the combination of a Technology Delphi with a Society and Culture Delphi. Both parts of Delphi Austria overlapped with respect to 4 thematic fields (see Table 1). The thematic fields in Delphi Austria were selected mainly on the basis of preparatory studies, which encompassed an analysis of foreign Delphi studies, a strength/weakness analysis of the Austrian competitive situation, secondary analyses of existing (economic) studies, a survey among 370 experts, a consumer survey (1,000 persons questioned) and a media and trend analysis.

[11] Note: *Unless stated otherwise, all opinions reflected in these case studies are those contained in the reports reviewed themselves and do not represent the opinion of the author of the case study..*

Technology Delphi	Society and Culture Delphi
Lifelong Learning	Lifelong Learning
Environmentally Sound Construction and New Forms of Housing	Environmentally Sound Construction and New Forms of Housing
Medical Technologies and Supportive Technologies for Elderly	Medical Technologies and Supportive Technologies for Elderly
Cleaner Production and Sustainable Development	Cleaner Production and Sustainable Development
Organic Food	Ageing and Life Cycle
Mobility and Transport	Structural Change of Work
Tailor-Made New Materials	Social Segmentation

Legend: The shaded overlapping thematic fields were also treated in an integrative analysis

Table A1: Thematic Fields in the Parts of Delphi Austria

A2.1.4 Method and Procedure

In contrast to other small countries, Austria preferred the Delphi method to expert groups, scenario techniques etc. to avoid undue influence of opinion leaders or lobbyists, to allow drawing on the expertise of as many different persons as possible, and to motivate as many decision makers as possible to reflect about the future by answering the questionnaire and, by this, to directly influence the innovation process.

The questionnaire of the Technology Delphi contained a self-assessment of expertise for each statement, the statements/hypotheses describing the state of innovations, and questions to assess them (regarding innovativeness, importance, chance of realisation within 15 years, desirability, chance of Austrian thematic leadership in R&D, economic exploitation, organisational and societal implementation), lists of policy measures to be assessed, questions for suggestions for other innovations, and an assessment of 17 so-called 'megatrends'. For each thematic field, different experts were addressed. After the first round with 3,748 experts addressed and 1,638 responses, the questionnaire was revised. In the second round, 1,127 experts responded (response rate of 71 %).

The questionnaire of the Society and Culture Delphi also contained a self-assessment of expertise, statements/hypotheses of almost 400 social, cultural, economic and political trends, questions of relevance/importance for the Austrian society, desirability of the trend, potential for realisation in 5, 15, 30 years, degree of priority for Austrian politics, degree of priority for Austrian research policy, and the degree of conflict potential for Austrian society. In the first round, 4,102 experts were addressed and 1,764 answered. After revision of the questionnaire, 1,040 experts responded in the second round (response rate of 64 %).

The questionnaire were developed and analysed by the implementing bodies (ITA and ITK) and by 14 expert panels for each thematic field. The extensive involvement of experts in these procedural steps were considered as an innovative bottom-up approach by the organisers.

A2.1.5 IST in Delphi Austria

It is difficult to distil a coherent IST vision from Delphi Austria due to the patchwork character of the IST mentions. No significant R&D and economic strengths in the develop development or production of specific hardware were seen, but multiple IST applications were envisaged within the fields education, work, production, mobility, medicine, ageing society, and material

developments. They were evaluated as partially leading to future economic, research and organisational potentials for Austria.

A2.1.6 Other Important Results of Delphi Austria

Delphi Austria referred at several points to the European dimension:

- In the field of physical mobility, participation in the European standardisation process for IST applications and the intensified (R&D) cooperation on a European level were proposed policy measures.
- A few experts suggest the development of European education software and a Europe-wide education server.
- Beyond IST applications, participation in European standardisation in the field 'physical mobility', the influencing of EU research programmes for 'new materials' and the intensified cooperation (in the field 'new materials') were suggested as policy measures.
- The agricultural, structural and regional policies of the European Union were considered as being oriented towards principles of sustainable development and as leading to environmental innovations in Austria.
- There was seen to be a need for European research related to measures for the broad implementation of a sustainable development.
- A shift of some policy areas to the European Union was proposed for the fields 'lifelong learning' (programme concertation, common credit system), 'medical technologies' (coordination of education and professions), 'physical mobility' (higher European emission standards, common admission office, common recycling obligations) and 'structural change of work' (e.g. adaptations of labour regulations), partially also for the policy measures for a sustainable development.
- Common taxation and social policies of the European Union were proposed and evaluated as helpful to reduce locational competition between member states for companies ('Standortwettbewerb').
- A need for European research was seen in the problem areas of the 'social segmentation', also a European policy need due to the problems' momentousness.
- The implementation of the Euro was partly held responsible for an increasing international specialisation of companies, increased international interconnectedness of the economies and therefore aggravated conditions for environmentally sound activities.
- Furthermore, European environmental taxation according to the polluters-pay-principle was expected to be implemented.
- The European level is used as a benchmark to argument for higher Austrian expenditures for research and innovation policies. In this context, Austria was regarded to have a strong position in European R&D initiatives in the field of 'tailor-made materials'.

One of the main general results of the Technology Delphi was the asserted dominance of organisational innovations over technology innovations. For instance, in the thematic field 'lifelong learning' three quarter of innovations were regarded as organisational innovations. Chances of Austrian leadership were seen by the respondents mostly in fields in which Austria already had a strong position, i.e. fields with high (not highest) technology built in mid-tech products with highest quality. 'Simulation technologies' for specific applications were regarded as the most promising technology application of all. The broad inclusion of societal aspects was one of the innovative elements of this foresight exercise. Therefore, the description of the main results of the societal trends is provided in the following:

- a further segmentation in all societal areas (i.e. work, housing, prevention, health, information, gender) will take place,

- the state retains the control function, e.g. in environmental and education policy,
- an increase in the importance of civil society through new forms of community activities is likely,
- risk and responsibility will be shifted from society to individuals,
- an outsourcing of services from centralised institutions to decentralised networks will come,
- individual fundamental needs (work, education, housing) will be reduced,
- demographic change effects the 'inter-generation agreement' ('Generationenvertrag') as well as construction and housing, and
- the nation state retains importance as political actor, but is complemented by additional political levels, i.e. the regions and the European Union.

The proposed policy measures which were regarded as important had the character of broad networking-orientated measures including organisational aspects, rather than individual promotion measures. In detail, the policy recommendations encompassed the promotion of cooperation between research and companies, and among themselves. Also pilot projects and experiments were recommended. They should have a mandatory participation of research and industry and first of all, being organisation-orientated, address the low trust in this kind of solutions and improve developments at the interface between technologies and organisations. Furthermore, the establishment of new institutions (i.e. Competence Centres) and the promotion of regional cluster-building was suggested.

By those responsible for the study, Delphi Austria was regarded as having a significant impact on Austrian technology policy with concrete impacts (Aichholzer 2001, p.23). For instance, it inspired the so-called 'Target Impulse Programme', including the establishment of Competence Centres. However, the actual relationship between Delphi Austria and the establishment of the Competence Centres remains unclear since 8 of the 18 competence centres operating in February 2003 were involved in IST R&D and an additional 2 in specific IST applications (mainly simulation). Additionally, subsequent research programmes were direct promotion programmes for IST R&D, e.g. the Impulse Programme 'Forschung, Innovation, Technologie: Informationstechnologien' (FIT-IT). Furthermore, the organiser of Delphi Austria claimed that Delphi Austria can be seen as an input to the formulation of the so-called "Green Paper on Austrian Research Policy 1999" and stimulation of cluster building. Delphi Austria was considered to have triggered subsequent analyses partly with foresight character focussing on mobile communication and the 'new economy'. The involvement and networking of participants was regarded as a positive impact in itself, although some observers deny that Delphi Austria led to the emergence of a foresight culture An informal internal assessment by the Ministry of Science and Transport stated that 110 Million Euro were invested in public R&D initiatives, which were recommended or confirmed by results of Delphi Austria.

A national plan R&D presented by the Austrian Council on R& D contained a single reference to Delphi Austria, so there are also doubts concerning its influence.

A2.2 Czech Republic – Technology Foresight 2002

A2.2.1 Summary

This was a one-year exercise lasting from 2001-2002 with the aim of drafting a National Research Programme (NRP). Work included the identification of key technologies and setting up a proposal for the administration of the Programme. There were 14 expert panels on thematic fields in addition to 3 on cross-cutting subjects. The panels drew on foreign expert advice and specially prepared reports. The final outcome is titled ”Proposal of the National Research Programme”.

A2.2.2 Background and Objectives

The Czech technology foresight project is the result of preparations of a National R&D policy (NRADP) run jointly by the Research and Development Council of the Czech Government and the Ministry of Education, Youth and Sport. This set up 9 working groups in 1999 and as a result of their work, technology foresight was identified as a means to develop a National Research Programme: “Annex III.2 to NRADP is the *“proposal of the Procedure for Determining the Partial Thematic Programs (Priorities) of the National Research Program (2001-2004)”*, which is the document stating that one of the modern and verified procedures suited to defining the particular priorities (of the *National Program of Oriented Research*) is “Technology Foresight”, utilizing the Delphi method”. (Aim 2000, p. 5).

The National Research and Development Policy was adopted by the government of the Czech Republic in January 2000. The Ministry of Education, Youth and Sports issued a public tender for the elaboration of a proposal for the National Research Programme (NRP), with a final deadline in September 2000.

The value of the contract has not been made public, but the amount is thought to be equivalent to the funding given foresight in other countries, such as the UK, adjusting for the size of the country (Aim 2000, p. 7). The resulting sum is approximately 255,000 GBP (€400,600, ibid.).

The aims of the foresight study were to specify the selection of priority research activities and to propose a process for programme implementation. The time horizon was 10 years. More specifically, the goals of foresight were to identify the research directions of greatest strategic importance for favourable economic development and for the fulfilment of the social needs of society, while making best possible use of limited public funds.

The contract for the project was awarded to the Technology Centre of the Czech Academy of Sciences in cooperation with the Engineering Academy of the Czech Republic. The project had a duration of twelve months with the final report published in March 2002. The Czech Foresight Study is the second such study, following the Hungarian Technology Foresight, to have been completed in a Central and Eastern European EU candidate country.

The proposal for an NRP necessitated the design of separate main programmes and cross-cutting programmes, their specification by devising sub-programmes consisting of systematic measures and the allocation of key research directions to each such sub-programme.

Equally important was the task of drawing up a proposal for the organisation of the National Research Programme, covering such matters as organisation, management and supervision,

regulation of competition and principles for financial support, evaluation, international cooperation and information policy. The organisation of the NRP was the subject of a special panel, while the programme itself was developed by means of a multi-step foresight exercise.

A2.2.3 Organisation of the Foresight Exercise

The preparation phase for the Czech technology foresight project included an evaluation of information on similar projects in other countries. A number of foreign experts from France, Germany, Hungary, Portugal, the UK, the European Commission and the JRC-IPTS provided advice and guidance on matters of methodology and procedure.

The project itself consisted of six phases:

1. A preparatory phase in which the structure of the project was determined.
2. Collection of information and documents for work in the panels, e.g. by interviewing industrial users, compiling statistics and computing costs, studies by external experts (e.g. analyses of strengths, weaknesses, opportunities and threats - SWOT).
3. Work in the panels, consisting of the identification of important and key research directions, on cross-cutting issues, the proposal for NRP management and organisation, and preparation of final reports of the panels.
4. The working group on the structure and management of the NRP, implementation and management principles.
5. Production of a final synthesis report for the client.
6. Final conference, publication and dissemination.

A major part of the work for the project took place in the panels, which each consisted of 15 to 20 experts representing both the supply side of R&D (production of knowledge and innovations), and the demand side (utilisation of knowledge and innovation, usually industry, but also the State). The panels produced justified proposals for priorities in the individual thematic and cross-cutting programmes of the National Research Programme. The proposals were in the form of written reports. There were a total of 18 panels, 14 of them thematic, 3 cross-cutting and the remaining one concerned with the organisation and management of the NRP.

The focus of the panels is partly on groups of technologies, partly on industries and application areas, and partly on social functions.

The subjects of the cross-cutting panels were:

1. Human resources for research and development
2. Integrated research and development
3. Regional and international competition in research and development.

In addition, there was the previously mentioned panel on management and implementation of the National Research Programme. Each panel was managed by a chairperson supported by the panel's secretary. These were recruited according to the same principles as the panels themselves, i.e. a mixture of representatives of research organisations, associations (mainly industrial), and industry. The project was managed by a "management group", headed by a project coordinator from the Academy of Sciences, with a deputy from the Engineering Academy, and a staff of seven, five of whom came from the Academy of Sciences, and the other two from the Engineering Academy.

A2.2.4 Method and Procedure

The panels started their work with a sector analysis, identifying the importance of each sector for the Czech economy and analysing existing R&D efforts. This phase also included an analysis of existing strategic documents and R&D programmes of the ministries.

Additional information was collected by interviewing managers responsible for R&D strategy in the individual sectors covered by the panel.

The panels held brainstorming sessions and structured discussions with a total of 5 meetings per panel. (cf. Klusacek 2001). Each panel also commissioned a series of expert studies.
Preliminary results were produced about half-way through the project and the contents of the resulting interim report were presented to the public. Following a panel meeting, the interim report was revised, and following another round of panel meetings and expert comment, the final report was presented at a national conference.

Participation appears to have been restricted mainly to experts, either through involvement in the panels or the expert interviews.

The final report bears the title "Proposal of the National Research Programme – Technology Foresight in the Czech Republic 2002". It includes a proposal for an organisational structure of the national research programme, which reflects the priorities pinpointed by the experts participating in the panels. The programme is subdivided into five main thematic programmes:

1. Quality of life
2. Information society
3. Competitiveness and sustainable development
4. Energy for economy and society
5. Modern society and its changes.

Each of these thematic programmes is further subdivided into so-called sub-programmes, of which there are in all 19 containing a total of 90 key research directions. There are furthermore three cross-cutting programmes: Human resources for R&D, integrated R&D, and regional and international cooperation in R&D. These three programmes were sub-divided into 19 cross-cutting sub-programmes.

A2.2.5 IST in the Czech Foresight Programme

IST played a role in several of the thematic panels in the Czech foresight study. The main panel with IST as a topic was titled "information society", rather than information technology. IST figured in the work and thematic priorities of several other panels: agriculture and food, environment, health care, pharmaceutics, civil engineering, urbanism and housing, materials and technologies for their production, discrete manufacturing, modern instruments and devices, the transport system, social transformation and integrated research and development.

A2.2.6 Other Important Results of Czech Foresight

Other important findings by the panels include:

- **Cross-sectional panel "regional and international cooperation in R&D":** identified growing importance for institutions of higher education in regional development and for competitiveness of the regions, importance of innovation for economic growth and the complementariness of innovative SMEs and large-scale industry. Threatening shortage of

well-educated personnel and the danger of migration could be compensated by similarly qualified personnel from non-EU countries, principally in Asia. Joint action by all regions is required to compensate for disparities among themselves, i.e. to support less advantaged regions. The importance of cooperation and participation in the European Research Area (ERA) is also underlined by this panel.

- **Special panel for the management and implementation of the National research Programme**: investigated two basic options for the management of the National Research Programme namely centralised management with a single authority and decentralised management with the consequence of greater participation by ministries and official administrative bodies. The panel favoured centralised management and drew up a set of principles for its implementation.

The final report from the Foresight Project recommends the continued use of the pool of experts to develop updated versions of the NRP through the setting of newly identified priorities. Another recommendation by the Czech experts, supported by the international expert panel, is to continue foresight activities in the Czech Republic. A first step toward this goal is a detailed evaluation of the first project with the aim of developing a proposal for a follow-up. Further steps include setting up the required institutional structure to carry out complex strategic studies focused on the identification of research and technology priorities and participation in EU level activities in the area of foresight.

The results of the project have been used for the preparation of the proposal for the National Research Programme, which was scheduled to become effective in January 2003.

A2.3 France – Technologies Clés 2005

A2.3.1 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

A2.3.2 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):

- 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.

A2.3.3 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.

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.

A2.3.4 Method and Procedure

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

A2.3.5 IST in Technologies Clés 2005

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.

A2.3.6 Other Important Results of Technologies Clés 2005

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 cooperation 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'.

A2.4 Germany – "Futur" – The German Research Dialogue

A2.4.1 Summary

This exercise took place from 2001 to 2002, with a pilot phase several years earlier. The goal is to formulate visions for programmes operated by the research ministry. It has a strong participatory element, attempting deliberately to engage certain societal groups (young people, women, artists, journalists) in the dialogue to provide input for the strategic research funding policies of the BMBF by means of an orientation towards societal goals. "Futur" has a very open approach and the exercise amounts to a selection process cascading from the very broad to quite narrow focus. The time horizon is 20 years and methods include workshops, open space discussions, panels, scenarios and lead visions, future workshops, electronic communication (online-voting) and road shows. Main outcome of Futur were four guiding visions. In all four guiding visions, aspects of IST are more or less relevant, but none of these visions are in a classical sense IST themes. This results the demand driven approach of the formulation of research themes.

A2.4.2 Background and Objectives

In the early 90s Germany started a couple of foresight like activities (Dietz 2002, p. 4 ff.; Meister et al. 2001, p. 5 ff., Cuhls 2001). The first German Delphi-Report was conducted from 1991 to 1993, commissioned by Federal Ministry of Research and Technologies (BMFT). In the same period, a study "Technologien am Beginn des 21. Jahrhunderts" took place (Grupp 1993, 1994). A so called "Mini-Delphi" was carried out in 1994 and 1995 in Japan as well as in Germany (BMBF 1996). The second German Delphi took place from 1996 to 1998 (Cuhls et. al. 1998).

Following the replacement of the former conservative Kohl-government by the newly elected "red-green" government the German BMBF started in 1999 a pilot, which dealt with two subjects "mobility and communication" and "health and quality of life" (Meister et al. 2001, S. 7). This had been influenced by international developments in the field of foresight which integrated a more participatory and dialogue-oriented approach as well as an approach which is more oriented towards social demands than technological proposals or promises. A central element was an electronic discussion space via Internet. It was to be used to discuss in an open and public dialogue the main technological and social trends in the two mentioned fields. Reflecting the weakness of this approach, "Futur: The German Research Dialogue" was established in 2001. The objective of Futur was to provide input for the strategic research funding policies of the BMBF.

Main aims of Futur are (cited from the Futur website):

- Orientation towards a societal goal, for instance solving a pressing problem of society,
- Connection of the needs of the society with technological and social innovation,
- Contribution to strengthening Germany as a site of economic production,
- High degree of complexity and interdisciplinarity,
- General comprehensibility.

A2.4.3 Organisation of the Foresight Exercise

The Federal Ministry of Education and Research entrusted a consortium with the organisation of "Futur". The "Futur" consortium had the responsibility to organise an open and creative

process between experts and the public, but it was to be neutral relating to contents. The consortium was the organiser and moderator of the "Futur" process.

BMBF wished to implement the results of "Futur", so it was important for the ministry to be involved in strategic decisions on the "Futur" process. To establish a balance between the openness of the discourse and the practical demands of the ministry, which needed some steering action, was a difficult but necessary task. The role of the research administration increased gradually from stage to stage.

The active participants of Future consisted of two groups: an inner circle and an outer circle. The inner circle consisted of about 850 persons. Its role was to participate actively in the workshops, conferences and other events of Futur. The outer circle consisted of about 600 persons and its main task was to comment and evaluate the proposals of the inner circle via an online voting-instrument with a return rate of 25 percent (Banthien et al. 2002, S. 33). The intensity of involvement in the process was quite uneven, extending from merely passive monitoring to active work in workshops (Dietz 2002, p. 10).

The participants in "Futur" consisted of a broad spectrum of persons from different parts of society: scientists, entrepreneurs, representatives of associations and social institutions and artists. Special emphasis was put on having young scientists and women (almost one third) among the participants. The aim of having one third from science, one third from industry and one third from the remainder of society was not achieved. The participants from science formed the vast majority, while the participants from industry came mainly from big business (Banthien et al. 2002, p. 35).

A2.4.4 Methods and Procedure

"Futur" started in July 2001 with 9 workshops involving nearly 400 experts. The outcome of this first stage of "Futur" was a collection of 10,000 topics, many redundant, dealing with societal problems and possible solutions of science (Dietz 2002, p. 11).

The "Futur" Consortium evaluated this collection and presented a list of 21 packages of subjects with 63 themes. Some examples of these 63 themes are: "The Portable Memory" (Das tragbare Gedächtnis), "Communicating Houses" (Kommunizierende Häuser), "Molecular Farming – Plant as Factory" (Die Pflanze als Fabrik), "Teleoffice in the Rucksack – Mobility without Locomotion" (Das Telebüro im Rucksack: Mobilität ohne Fortbewegung) (Dietz 2002, S. 17 f.).

In the third phase of "Futur", a conference with about 300 participants from the inner circle took place, focusing on 25 themes (topic packages). The conference was also the starting point for building focus groups to elaborate the themes further. The focus groups consisted of 5 to 30 persons. Special attention was given to interdisciplinary composition. Later, the 25 themes competed with one another (Dietz 2002, p. 13). The 25 clusters of themes from this stage were oriented towards the main sectors of societal demand. Examples are: "Promotion of Intercultural Biodiversity" (Die Förderung interkultureller Biodiversität) or "Anticipatory Planning and Design of Liveable Work in the Knowledge Society" (Vorausschauende Planung und Gestaltung lebenswerter Arbeit in der Wissensgesellschaft) (Dietz 2002, S. 18, see also http://www.futur.de/en/321.htm, received 09.01.2003).

Of the 25 themes and the former 63 themes from the second stage, 13 were selected for further processing (focus topics) in Autumn 2001. There were two main inputs for this selection proc

ess: on the one hand, a survey within the research administration of the ministry and its project management agencies (Projektträger), on the other hand the Online-Voting of "Futur" participants including the outer circle (Dietz 2002, p. 13 f.). The following 12 focus topics are listed on the "Futur" website (http://www.futur.de/en/674.htm, received on 09.01.2003):

1. Farsighted Planning and Organisation of Satisfactory Work in the Knowledge Society
2. Germany as a Place of Learning – the Learning Society as a Factor of the Future
3. Living in a Networked World: Individual and Secure
4. Promotion of Intercultural Potentials
5. Dealing with Knowledge
6. Sustainable Mobility
7. Individual Medicine and Health Care 2020
8. Ways of Developing a Sustainable Nutrition Culture in a Changing Society
9. Sustainable Agricultural Production With Global Responsibility
10. Global Change – Regional Change: Recognising the Challenges and Opportunities of Global Change and Shaping Them Regionally
11. Decentralisation – A Strategy for Sustainable Ways of Life and Work?
12. Intelligent Products and Systems for Tomorrow's Society/ The Intelligent Product

In March 2002 the themes were again focused on six future scenarios. Again the research administration was surveyed and "Futur" participants were able to vote on the themes electronically. 300 "Futur" participants took this opportunity. It is worth mentioning that the results of the selection process by the research administration and the "Futur" participants in stages four and five were nearly the same. At this stage of Futur the Innovationsbeirat (innovation council) of the ministry was also involved in the decision process. The Innovationsbeirat is the high level advisory council of BMBF consisting of 12 persons from science, economy and NGOs (Dietz 2002, p. 15). The six favourites from this stage were (http://www.futur.de/en/5447.htm, received on 09.01.2003):

1. Individual medicine and health 2020
2. Access to the world of learning
3. Living in a networked world: personalised worlds of interaction
4. Efficient processes of knowledge
5. Intelligent processes
6. Understanding Thought Processes (added in June 2002 to the list of five)

A2.4.5 IST in FUTUR

Main outcome of Futur were four guiding visions (see below). In all four guiding visions aspects of IST are relevant, but none of these are in a classical sense IST themes. This relates to the demand driven approach of the formulation of research themes. Most of all, the vision of "Networks" involves more or less classical IST themes and the vison "Understanding thinking" is on the innovative side of IST research.

A2.4.6 Other Important Results of FUTUR

Until summer 2002, four of the six themes from stage five were developed into guiding visions (also called "lead visions", in German "Leitvisionen"). This marks the end of "Futur" and the beginning of the implementation process. The ministry, with support from the Innovationsbeirat, will implement in an appropriate manner these outcomes from Futur in its further research planning. It is clear that the role of the research administration is getting higher and higher from stages four to six (Dietz 2002, p. 16).

The four guiding visions are (http://www.futur.de/en/5296.htm):

Living in the Networked World: Individual and Secure

Two aims were of primary importance: 1) The digital networks must be oriented at the needs of the user and preserve the autonomy and individuality of the users. "Networking is not an end in itself" ("Futur" 2002, p. 42). 2) The digital network has to be a reliable infrastructure, allow bi-directional flow of information and has to be ubiquitous and invisible.

The future research priorities for this lead vision are ("Futur" 2002, p. 50 ff.):

1. Human-Machine Interaction and Mobile devices,
2. Embedded Systems,
3. Software Agents,
4. Networks and the Structure of Service Supply,
5. Security.

The authors further discuss non-technical innovatory factors and the need for interdisciplinary research.

Understanding Thought Processes

This guiding vision seems to be the most ambitious in terms of establishing an innovative field of science. The catchwords are: computational neuroscience, bioanalogous information processing, neuroimplantations, future computer architecture based on asynchronous dynamics, error tolerance, associative data processing, organic computing, neuroprotheses like artificial retina, systematic biology (Systembiologie). It is pointed out that Germany has a good position in these fields, but also that international competition is quite strong. Recently massive growth in support for research and educational programmes can be observed in countries like USA, Israel, Switzerland and Japan. To prevent qualified experts from Germany from emigrating to other countries, there is a need for a big effort to establish a regional concentration of high ranking interdisciplinary expertise in Germany. A real challenge is to make the transition from theory to experiments and to educate young scientists in an interdisciplinary manner in the field of the neurosciences.

Creating Open Access to Tomorrow's World of Learning

In this guiding vision the themes are predominantly oriented more or less towards classical themes of education research with an emphasis on changing and supplementing established structures and implementing new forms of learning. Future support for research should concentrate especially on the following points: evaluation strategies for ensuring innovation transfer, registration and certification of informal learning, motivational and criterial research, networking of learning locations, learning by teaching, E-learning.

Healthy and Vital throughout Life by Prevention

In this vision great importance was attached to an interdisciplinary approach and the demand for implementation and transformation of present research results. Thus three research priorities were recommended: systematic data gathering and evaluation, implementation, acceptance/ethics. The authors' opinion is that in the area of health technology support priorities already exist, but that a systematic and holistic approach has hitherto been neglected.

A2.5 Hungary – Hungarian Foresight Program

A2.5.1 Summary

Hungary was the first accession country to run its own foresight programme, which took place from 1997 to 1999. Its goals included enhancing competitiveness, improving quality of life, identifying problems to be addressed by research, identifying required changes in regulation and government policies and outlining possibilities of meeting the challenges of EU accession. It had a time horizon of 15 to 25 years and was organised in 7, later 8, thematic panels, each consisting of between 11 and 24 experts. The exercise involved background papers, Delphi surveys by most panels and the development of scenarios. Over 2000 experts participated in the Delphi surveys. Results were disseminated and discussed in a large number of workshops (over 100).

A2.5.2 Background and Objectives

The Hungarian Technology Foresight programme itself was initiated in 1997 and launched in 1998 by the National Committee for Technological Development (OMFB). It was the first foresight programme in the Central and Eastern European countries. Part of the work consisted of an analysis of the strengths and weaknesses of the Hungarian economy and R&D system.

The goals of the Foresight Programme were to contribute to the selection of long-term research goals and priorities ("picking winners") and to consensus-building and transparency on the application of such key technologies as information technology, biotechnology and nuclear energy. Technology Foresight was also regarded as a suitable instrument to support decision making in areas of science and technology characterised by interdisciplinary cooperation. In this sense, Technology Foresight was seen as a means to overcome the rigid system of discipline-oriented science. A major supportive role for Technology Foresight was seen in devising long-term strategies through its ability to promote dialogue between various stakeholders, notably researchers, company managers and government officials, and also through its ability to generate alternative visions.

The questions guiding the Hungarian Foresight Programme were as follows:

- Foreseeable social and economic trends in the next 15 to 25 years, the opportunities created by research and development of technology and innovation, identification of the problems to be addressed by researchers;
- The most effective ways to exploit the country's resources towards the goals of economic prosperity and improvements in the quality of life;
- Required changes in regulation and government policies.

A2.5.3 Organisation of the Foresight Exercise

The Hungarian Foresight Programme was modelled largely on the first cycle of the British Technology Foresight Programme. Panels were set up to develop and explore scenarios and to formulate policy recommendations. The other major component was a large-scale two-round Delphi survey. In this sense, the Hungarian Foresight Programme is a fully-fledged foresight study.

The steering group was composed of members nominated by ministries, government agencies, professional associations and chambers in mid-1997. The majority of the 20-member Group

was deliberately selected among industrialists and academics with close contacts with business. Participation was on the basis of personal knowledge and experience and rather than representation of stakeholder interests (cf. Havas 2002a, p. 4).

An inter-ministerial committee was established slightly later to discuss the preliminary findings of the Foresight Programme and to provide the steering group and panels with timely information on initiatives relevant for their work.

The foresight process itself was prepared with a series of awareness seminars directed at experts and professionals ("Pre-Foresight"). Panel members were nominated by seminar participants and organisers – usually chambers of commerce and professional associations – and by government ministries and agencies. There were also advertisements in newspapers drawing attention to the study and offering experts the opportunity to join the project.

The topics of the panels were selected by the steering group. The chairpersons and secretaries of the panels were appointed by the steering group, while panel members were invited by the chairpersons and secretaries, partly on their own account and partly on the basis of suggestions from the awareness workshops.

Initially, there were seven panels on Human resources (education, employment), Health, Information technologies, telecommunications and media, Natural and built environment, Manufacturing and business processes (new materials, production processes and manufacturing techniques, supplier networks), Agri- and food business, Transport.

A smaller panel on energy was set up later in the process on request from the other panels. This did not take part in the Delphi survey. Each of the main seven panels had between 18 and 24 members, with the exception of the "human resources" panel which consisted of 11 members.

Hungary structured its foresight programme partly on the basis of technologies (information technologies), sectors (agriculture and food, energy), but also social functions (health service provision, transport, education).

A2.5.4 Method and Procedure

Each of the panels produced a status quo report on the situation in Hungary in its field, consisting of an analysis of human resources, techno-economic performance, the institutions and regulations effective in the area, foreseeable technological and socio-economic trends. They also developed alternative visions (or scenarios) for the future. The reports were partly based on the expertises of panel members and partly on specially commissioned reports from other experts. The reports were discussed at over 100 workshops throughout Hungary, again organised by the chambers of commerce and professional associations. In addition, all reports and background material were posted on the Internet as soon as they became available.

Each panel commissioned between 15 and 25 background reports and the seven original panels formulated questions for the Delphi survey, which formed the other major component of the Hungarian Foresight Programme.

The statements in the Delphi survey were formulated and validated by the panels, who drew partly on work done in other countries (Japan, the UK, Germany and Austria). Each questionnaire consisted of between 60 and 80 statements. The potential respondents were identified by a process of co-nomination. The process itself was organised by a commercial pollster company, selected following a call for tender. The target minimum sample size was 200 respon

dents per panel subject and around 1400 completed questionnaires were received in the first round of the survey.

The procedure for completing the questionnaires was very similar to that employed elsewhere:

- Ranking of respondent's own expertise in the subject area (unfamiliar, casually acquainted, knowledgeable, expert).
- Assessment of economic and social impact, and impact on the natural environment (scale from "strongly harmful" to "significantly positive").
- Estimation of period within which the development concerned would take place (up to "never").
- Rating of relative position of Hungary compared to advanced European countries in four respects: S&T capabilities, exploitation of R&D results, quality of production and services, efficiency of regulation on a scale extending from "unacceptable" via "fairly similar" to "higher level".
- Assessment of the existence or lack of restraints of various types: social/ethical, technical, economic, financial, regulatory, education-related (simple yes/no dichotomy).
- Ranking of various policy tools with regard to their suitability for the promotion of development and application: domestic R&D, purchase as licenses for know-how, ready-made products.

The first round of the Delphi survey was completed in May 1999, the second at the end of the same year. The data produced by the survey was used primarily by the panels for their own final reports.

The panel reports are a synthesis of the background reports, panel discussions, the results of the Delphi survey and of the conclusions from the previously mentioned regional workshops. Each report had a similar structure: a critical appraisal of the present situation (a kind of SWOT analysis), a description of alternative future visions and recommendations for the realisation of those visions regarded as most feasibly desirable (i.e. the best realistic outcomes).

The draft panel reports were discussed at a national conference in June 2000 and revised to incorporate feedback from this conference. Electronic versions were produced a few months later, with printed versions of the final reports becoming available in May 2001.

The report by the steering group recommends dissemination of the results until the end of 2002. The steering group also suggests further assessment exercises during the dissemination phase, e.g. mini-Delphi exercises at professional meetings, and also the setting up of "shadow" working groups consisting of PhD and graduate students to monitor the implementation of recommendations and to feed new thinking into the preparations for the next phases of Hungarian foresight. The steering group further suggests that the result of the national programme could be used to launch regional foresight programmes, or programmes closer to industry, e.g. by firms, businesses or professional and industrial associations.

A2.5.5 IST in the Hungarian Foresight Programme

Apart from the panel on Information technologies, telecommunications, media, which was obviously concerned mainly with IST, most other panels' work had IST aspects, notably the panels on Production and Business Processes, Agriculture and Food, Health and Life Sciences, Protection and Development of the Natural and Built Environment, Transport, Education and Human Resources.

The final report by the steering group underlines the central importance of knowledge in driving societal change, also arguing for "flatter", flexible and adaptive organisational structures in addition to a system for lifelong learning. It contains a total of 22 recommendations, of which several refer to information technology.

A2.5.6 Other Important Results of Hungarian Foresight

According to Havas (2002a, p. 27) the panel reports including their policy recommendations have been discussed and received favourably by parliamentary committees. In some cases, the committees urged ministers to form task forces to investigate the implementation of recommendations (e.g. in health care, education, the environment).

Certain recommendations have been incorporated in policy documents, e.g. by the Ministries of the Environment and Transport or by the Government Commissioner for Information Technology. Former members of the health panel have since been appointed Minister and the coordinator of a new health programme. The latter programme was launched partly as a result of the panel's findings. A recommendation by the Steering group on schemes for sabbatical leaves for scientists and engineers working for companies has also been implemented.

The foresight process itself is described as an important "result" (Havas 2002a, p. 27). The workshops are thought to have contributed toward strengthening or even creating networks among actors from the various communities with stakes in certain fields.

Havas (ibid, p.27f.) also feels that the process contributed to the adoption of "pluridisciplinary" thinking and approaches to certain problems and the development of policies to address them.

Although the majority of panel members were recruited from among scientists and engineers, the majority of statements formulated by these panels for the Delphi survey were of non-technical nature (ibid. p. 28). The dominance of socio-economic aspects was also reflected by the results of the Delphi survey itself, where non-technical matters were frequently greeted favourably and awarded high priority.

A2.6 Spain – Technological Foresight Programme (OPTI)

A2.6.1 Summary

This industry-oriented exercise was carried out in three cycles between 1998 and 2000. As Foresight has been institutionalized in Spain in form of an observatory, OPTI, the Observatory of Industrial Technology Foresight, activities still go on by means of the OPTI website (http://www.opti.org/), periodical publications, and new technology watch activities. The aim of the Technological Foresight Programme was to strengthen the national innovation system (NIS) by exploring future technological trends and the needs of Spanish industry, and by this means enhancing its competitiveness. Eight industrial sectors and eight sector specific industrial organisations were chosen to organise eight mixed expert panels. Each panel carried out a series of annual Delphi studies, with each year's survey focusing on a separate topic. All in all 26 Delphi surveys leading to 26 studies were carried out. More than 5000 experts, most of them stakeholders from industries, were involved, and the Delphi return rates were regarded as very high. Methods applied apart from panels and Delphi were the production of trend reports and scenario building activities in an ad hoc fashion. Although the findings of the panels for each sector were presented in one report, efforts to synthesize findings and to develop a general vision have not been very intensive. Strengths of these sector foresight exercises were obviously their close link to industry and R&D policy. The foresight process is also regarded as successful in terms of awareness raising and network building.

A2.6.2 Background and Objectives

Ten years after the end of the Franco regime and shortly after becoming member state of the European Union in 1986, Spain started to reorganize its research policy. The legacy of the Franco era was a highly centralised science and technology system, which was also not efficiently coordinated (cf. Héraud and Cuhls 1999). A National R&D plan was one policy instrument newly introduced to overcome the apparent deficiencies. The first R&D plan started in 1988 and ended in 1991, the most recent covers the period 2000-2003. A Spanish foresight programme was started in 1995 by ANEP, Agencia Nacional de Evaluación y Prospectiva. This agency, created in 1987, was basically related to the National R&D planning, evaluating project proposals. But it also carried out prospective analysis of its own in the order of magnitude of 10% of its budget. The idea behind this first programme was mainly to catch up with other European countries. There is another root of Foresight in Spain, namely the INIDES project (Identificación de las Necesidades de I+D de las Empresas Españolas), aiming at identifying the R&D needs of Spanish companies. This project was initiated by OCYT, the Spanish Presidential Directorate for Science and Technology (Oficina de Ciencia y Technología), and coordinated by COTEC, an entrepreneurial foundation. INIDES is more of technology watch type rather than a proper foresight project, but it remains nevertheless an important forerunner and an activity strengthening the interface between policy and industry.

Despite these early activities, for most observers real fully-fledged foresight in Spain starts with the establishment of OPTI, the Observatory of Industrial Technology Foresight (Observatorio de Prospectiva Tecnológica Industrial). This body was created in December 1997 by an initiative of the then Ministry of Industry with the aim to carry out foresight studies and technology watch with a focus on technological trends and the needs of Spanish industry. In 1999, OPTI acquired legal status as a Foundation with the support of and under the auspices of the Ministry of Science and Technology. The president of the Foundation is the Secretary of State for Science and Technology Policy underlining the close relation of OPTI to policy-making.

A2.6.3 Organisation of the Foresight Exercise

OPTI works as a network with a small central infrastructure and co-operates with eight Technological Centres linked to industrial branches. As the focus is on industry, the areas to be studied are industrial sectors, including not only emergent areas, but also traditional sectors (!). "Each Centre has own technological capability and direct relations with the industries, mainly SME, and contributes with its specific knowledge to develop the OPTI activities" (OPTI website; visited January 2003). The OPTI Technological Foresight Programme comprised foresight in eight sectors of the economy: agro-food; energy; environment; chemistry (4 sub-sectors); information and communication technologies; transport (4 sub-sectors: air, rail, ship, car), basic and transforming manufactures; and traditional industries (footwear, textile, toys, wood and furniture, glass and ceramic and jewellery). OPTI carried out the planning of the foresight activities aiming to identify those technological trends and visions, which are especially relevant for the future development of the industry sectors chosen. A common methodology was applied for the investigation of all sectors: Expert panels, Delphi methodology and scenario building were combined.

A2.6.4 Method and Procedure

The first step in the process was the selection of sectors (eight in the first stage of the study) and of independent technology centres specialised in these sectors. The sectors were selected by using indicators such as the contribution to GDP, the number of employees, their dynamic in the Spanish economy. The Centres were selected for their technological excellence, their links with the industry and their knowledge of the needs and the opportunities of the enterprises.

Responsibility for each sector study lay with the technology centres assigned. Each technology centre established its own expert panel, which in turn identified the broader number of experts to be consulted through the Delphi survey by co-nomination method, defined the topics of the questionnaire, and analysed the results of the survey. The Foresight Programme was organized as an iterative process in as much as one study per sector was carried out each year with a shift of focus every year. The total of 26 Delphi questionnaires was sent to 5000 specialists with an average return rate of 32% (after the second Delphi round). The information obtained from the questionnaires wasanalysed by the expert panels and additional experts. Since four studies were performed for the transport and chemical sectors, a total of 26 studies were produced. The results were published in three reports (OPTI 1999, 2000, 2001) and are available at OPTI's website.

The core element of the Spanish Foresight programme was the series of Delphi surveys addressing a diversity of issues including technological, environmental, economic and social issues, as well as the competitive position of Spain in different areas with respect to productivity, commercialisation and marketing. The Delphi method applied to identifying driving forces can be regarded as state of the art. For each statement, experts were asked to indicate:

- Importance: high medium, low, irrelevant
- impact on economic development, life quality, employment
- date of materialization: up to 2003, from 2003 to 2008, from 2009 to 2014, never
- scientific position of Spain relative to other countries (high, medium, low) with respect to S&T, innovation, production, commercialisation of technologies
- limits: social, technological, legal, economic, environmental

- recommendations: collaboration with external enterprises, incorporation of S&T in enterprises, cooperation firms, research, support from administration, diffusion of results

The foresight exercise led to lists of specific recommendations panel by panel. Working groups were set up for each sector after the study to identify "mega-trends", often defined in terms of broad generic policy objectives, and promising areas and technologies.

Such conclusions were fed into the definition of the Spanish national R&D plans and of the Spanish position in the negotiations leading to the definition of the European 6th Framework research programme. Results have also been published through books and, at the request of the Ministry of Industry, a document summarising the main project results was also produced. With OPTI a permanent organisation was set up to disseminate results, digest and present the results for policy formation, and develop further studies in new sectors

A2.6.5 IST in the Spanish Foresight Exercise

The Catalonian industrial centre ICT "La Fundación Instituto Catalán de Tecnología" (http://www.ictnet.es/) was chosen as responsible for the ICT studies. It designed the questionnaire with the help of a group of industrialists, including representatives from SMEs. The participants in the Spanish ICT Delphi were to a large extent from industry (80%), with only 20% coming from academia. The focus of the studies in 1999 was on Digital content industries, in 2000 on ICT and the emerging digital economy, and in 2001 on Convergence of infrastructures and services in the telecommunications sector.

ICT was also an issue in other sectors. One study dedicated to the "traditional sectors" such as leather, textiles, furniture, ceramics, toys and jewellery had a focus on the **potential of automation** in these traditional fields.

The first OPTI study 1999 also identified technology trajectories for the different sectors demonstrating that ICT have a role to play in most of them. The summary of the third OPTI report (2001, p. 411f) highlights eight fields in which ICT is crucial in non-ICT sectors. The potential for controlling, monitoring, simulation, and remote services are mainly pointed out here:

- Maximum automation of paper industries
- ICT for monitoring, controlling and simulation of transport processes, distribution, storage and final use of energy
- increased speed of car design and development; more flexible fabrication; standardisation of major components
- telematic control systems for the rational use of and intelligent distribution of different traffic systems
- value added services for machine-tools operated by the manufacturer like tele-services, tele- maintenance, communication, and access to technical data via broad band Internet
- consumer information systems on food
- dependable and transparent information systems about reuse of water
- monitoring and on-line control technologies about water resources.

The findings on the importance of ICT have however not been aggregated or synthesized into a general perspective on ICT and the development of the information society. This is probably due to the parallel approach oriented towards sectors.

A2.6.6 Other Important Results of Spanish Foresight

In general, the outcomes derived from the process are said to be at least as useful as the specific technical results and policy recommendations of the studies. Information exchanges, networking activities, and policy debates have led to new ways of communication across different societal groups and contributed to changing attitudes towards innovation and the importance of future planning when developing science and technology strategies. Particularly relevant has been the strengthening of communities of experts concerned with technology futures and technology watch activities. The foresight exercise contributed to building up a common culture oriented to develop and to use technology as an instrument to answer the future needs of society. In the eyes of OPTI (as expressed in IPTS-ESTO 2002) policy making has been eased by the growing recognition in Spain of Foresight as a tool to inform science and technology strategies. The national innovation system has changed: new institutional forms have been developed in which non-profit organisations (e.g. OPTI) work with industry, government and research organisations. In other words: more refined analysis of the issues at stake and a better awareness of the longer-term challenges have been achieved. In this sense, a new type of innovation policy has been implemented in Spain.

A2.7 Sweden – The Foresighted Society

A2.7.1 Summary

The Swedish Foresight programme is unique in that it was not conducted by or on behalf of the government. It ran from 1998 to 2000, including a long dissemination phase. It was organised in 8 thematic panels, involving an average of 15 experts per panel. The goals were "to strengthen a futures-oriented approach in companies and organisations, to identify areas of expertise with potential for growth and renewal in Sweden, to compile information and design processes for identifying high-priority areas in which Sweden should build expertise". Methods included scenario building and workshops in addition to an exercise called "technology hindsight", which was aimed at identifying causes for faulty predictions and assumptions on future technology. There were many workshops to disseminate and discuss results and a second exercise was launched late in 2002.

A2.7.2 Background and Objectives

As of 2003, Sweden is the only Nordic country to have carried out a wide-ranging national foresight exercise. The project was started in 1998 as the result of a preliminary study by the Royal Swedish Academy of Engineering Science (IVA) and the Swedish National Board for Industrial and Technological Development (NUTEK, as is was at the time). These two organisations were joined by the Swedish Foundation for Strategic Research and the Federation of Swedish Industries.

The overall costs were SEK 34 million (€3.74 million), of which half was provided by the Foundation for Strategic Research, SEK 10 million (€1.1 million) by NUTEK, and the remaining 7 million SEK (€0.77 million) by the Swedish government.

Despite this support, the Swedish foresight was not carried out on behalf of government, but of the four organisations mentioned previously. A major aim was the commitment of private companies, public agencies, and other interested parties to the foresight process.

The final report of the project, "The Foresighted Society", was presented on 28 March 2000, but according to the understanding of the four organisations, this only marked the end point of an introductory phase. Since then efforts have concentrated on a discussion of the future development of Swedish society and business, centred around the report. Among these have been more than 20 regional conferences, over 100 presentations for specific organisations or companies, dissemination via the Internet and via the human networks of which the four organisations behind the report are part.

The time horizon for the studies was 10 to 20 years depending on the subject under consideration, the main aim being to "create insights and visions about technological development" over such a period. The three main objectives of the foresight exercise were:

- To strengthen a futures-oriented approach in companies and organisations,
- To identify areas of expertise with potential for growth and renewal in Sweden,
- To compile information and design processes for identifying high-priority areas in which Sweden should build expertise.

A2.7.3 Organisation of the Foresight Exercise

The project was directed by a six-person steering committee with its own secretary and a project office, a project manager and four project officers, including one responsible for project controlling. In addition, an advisory panel consisting of representatives of around 30 organisations was set up to ensure that important Swedish stakeholders were integrated in the foresight process, to suggest names of possible panel participants, and to create involvement and generate support for the foresight exercise within the members' respective organisations, and to provide guidance for the work of the expert panels. Finally, an evaluation committee was set up to continuously monitor and evaluate the implementation of the foresight exercise.

The major part of the work done for the foresight project was carried out within eight expert panels, defined and staffed by the steering committee following a phase of discussion and definition. This was based partly on a review of comparable foreign studies and their lessons learned. The division into panel subject areas was made on the basis of user perspectives, not fields of technology:

1. Health, medicine and care
2. Biological natural resources
3. Society's infrastructure
4. Production systems
5. Information and communication systems
6. Materials and material flows in the community
7. Service industries
8. Education and learning

Each panel consisted of a chairperson and about 15 other members, a total of 130 in all. Each panel also had a project manager who worked at least half-time in this capacity.

A2.7.4 Method and Procedure

Work on the panels started in January 1999, with a kick-off conference. A joint conference for the coordination of the panels' work took place in August 1999 while work in the panels ceased after one year.

There was a recommendation by the steering committee for the panels to follow a uniform methodology within a firmly fixed timetable. Their point of departure was a project plan based on the lessons of technology foresights in other countries. The steering committee also asked the panels to consider selected cross-cutting issues, such as environmental and energy aspects, economy and the market, attitudes and values. Apart from this, the panels had freedom to define and prioritise their own tasks.

In general, this procedure was indeed followed by the eight panels. The first step was an inventory of a large number of subject areas believed to be of importance for society. Following discussion, these were grouped into issues and a number of key areas were selected for more detailed analysis. The panels were free to form sub-groups and to outsource assignments.

During Spring 1999, Sweden's Defense Research Establishment (FOA) developed four future scenarios to underpin the work of the thematic panels. These varied with respect to the role assigned to geographic proximity in development and with respect to the relative number of players involved in development. The degree of use made of these scenarios varied among the panels.

A novel feature of the Swedish Foresight Study was a separate study of earlier attempts to predict the future. This was termed Technology Hindsight (Teknisk Baksyn) and discussed the various difficulties and sources of errors involved in forecasting.

Drafts of the eight panel reports were posted on a project website for comment by all interested individuals. The results of the foresight exercise were publicly presented at a final conference in March 2000. There have subsequently been the presentations already mentioned and the entire process has been subjected to evaluation by the panel set up for this purpose, which reported to the four organisations running the project.

A2.7.5 IST in Swedish Foresight

One of the stated aims of the study was "to engage many of the players in Sweden's 'knowledge society' in a discussion of the best ways to promote a long-term interplay between technological, economic, institutional and social process" (The Foresighted Society, p.52). Accordingly, information technology, the new biology and increasing globalisation are seen as major drivers of societal developments in the coming decades (ibid., p. 4).

While there was a separate panel on information and communication systems, the final report also contains a chapter on "pioneering technologies", which includes among its three headings, one on IT. This singles out:

1. The rapid advances in computing power and capacity,
2. The development of telecommunications, particularly the advance of the Internet,
3. Advances in wireless telephony,
4. The use of computers for simulation.

IT was also addressed in the work of most other seven thematic panels beside that concerned with ICTs as such (cf. the synthesis report "The Foresighted Society").

A2.7.6 Other Important Results of Swedish Foresight

Eerola and Jørgensen (2002, p. 40) quote some of the main comments from the evaluation report:

- Participants, in particular from industry, appreciated the long-term character of the exercise which is in contrast to the conventional short-term perspective adopted in business.
- While the exercise tried to avoid a narrow technological focus by emphasising the broader societal perspectives, some evaluators felt that technological aspects were underexposed, at least by some panels.
- The tight schedule and need to write reports themselves to some extent distracted the panels from generating ideas. This could be avoided in future by providing more professional support.
- The use of scenarios to support outlining possible futures was not equally successful in all panels. Again, there is need to provide support during work with the scenarios.

Over all, the exercise was regarded as a success and an initiative was launched in 2002 by VINNOVA (a spin-off of NUTEK) for a new round of foresight. A formal agreement on this was signed in June 2002 and the project itself was launched in December of the same year.

A2.8 United Kingdom – Second UK Foresight Cycle

A2.8.1 Summary

The United Kingdom is currently involved in its third cycle of foresight. Each cycle has differed in its organisation from its predecessor, partly as the result of consultations with participants. The second cycle, which was brought to a premature end, ran from 1999-2002 and was organised in 8 sector panels and 3 thematic panels with another 30 so-called associate programmes managed by various organisations outside the Department of Trade and Industry, which was the main organiser of the programme. While a major aim was still to set priorities for science and technology policy, there has been a tendency to downplay this goal in favour of creating something like a "forward thinking culture" in the UK. Each panel was responsible for its own work and overseeing related task-groups or associate programmes. In contrast to the first UK cycle, this round did not include a Delphi survey, but there was a "knowledge pool". Public participation via websites, workshops etc. was stressed strongly for this cycle. The time horizon was 15 to 20 years.

A2.8.2 Background and Objectives

One of the main roots of UK foresight was a review in 1984 by Ben Martin and John Irvine of SPRU covering overseas foresight exercise. The client was the Government's main advisory body on S&T matters, the Advisory Council for Applied Research and Development (ACARD). In 1986, this council produced a blueprint for a national foresight exercise, which was never implemented following a recommendation that foresight was best left to industry. Although industry failed to follow through this recommendation, there were several Government departments or Research Councils which did foresight-like exercises designed to help identify priorities.

Following a general election, the incoming Government created a separate ministry for science and technology in the shape of the Office of Science and Technology (OST) in 1992. OST was situated in the Cabinet Office and thus close to the Prime Minister. The OST was given responsibility for the science councils, but responsibility for the bulk of public spending on science and technology remained with the ministries. OST was charged with the task of providing an overview of all public spending on S&T and with providing incentives for better coordination. The foresight programme was conceived in this context as a mechanism to improve the collection of information and for coordination.

The Office of Science and Technology became part of the Department of Trade and Industry in 1995. The Secretary of State (Minister) for Trade and Industry has overall responsibility for the UK Government's science policy and for support for science and technology in a cross-department role as Cabinet Minister for Science and Technology. There is also a Minister for Science (actually a Parliamentary Under-Secretary of State) within the Department of Trade and Industry, who is directly responsible for OST.

A technology foresight programme was among the recommendations included in a 1993 Government White Paper "Realising our Potential". Basis of this recommendation was a blueprint developed by PREST and PA in 1992. The primary aim of the foresight programme was to build and strengthen networks, more specifically to improve the connection between the science base and the goals of wealth creation and improved quality of life. Other aims included

the setting of priorities and the promotion of a "foresight culture", i.e. future-oriented thinking among actors with vested interests in science and technology.

The first UK foresight cycle involved work in panels, Delphi studies and a long period of public consultation. It has been highly influential in the design of technology foresight studies in other countries (Hungary, South Africa and Austria). It was regarded as such a success by it clients that a second cycle was launched in 1998. It is the second cycle of UK foresight which will most concern us here, since this was completed in 2000. A subsequent, third, cycle has taken a slightly different approach and is focusing on selected topics for "in-depth" treatment on an annual basis.

The second round of UK foresight was an outcome of two rounds of consultation toward the end of the first cycle in 1997/98. Preliminary discussions were held with a wide variety of interested parties: panels, companies, industry associations, universities, government departments and agencies, Research Councils, learned societies, think tanks and regional bodies. The results of these discussions informed a formal consultative document published in March 1998 by the Office of Science and Technology which contained specific proposals for the structure and approach to the new round. This was followed in December 1998 by a "blueprint" retaining most features of the earlier proposals, but going into more detail (cf. Georghiou/Keenan op. cit., p, 10f).

The aim of this exercise was to re-orient UK foresight to the changed conditions prevailing in the late 1990s, and also to address any gaps not filled by its predecessor. Its aims were ostensibly broadly similar to those of its predecessor, namely to develop visions for the future and to discuss options for current actions to address the challenges these visions raise, to build bridges between the various stakeholders in business, science and government, and to increase national wealth and quality of life (cf. Georghiou/Keenan op. cit., p.11).

A2.8.3 Organisation of the Foresight Exercise

The second foresight cycle began officially on 1 April 1999. It again employed panels as its means of division of labour. While the panels in the first UK foresight cycle had a focus on areas or sectors of technology, those in the second round have a more supply-chain-based approach oriented towards applications. In addition, the second cycle saw the introduction of three thematic panels as a new element. Georghiou/Keenan (op. cit. p. 12) regard the introduction of such thematic panels on the ageing population, crime prevention and manufacturing, as "symptomatic of a broader tendency to locate research in the context of socio-economic goals". The crime prevention panel was funded by the Home Office, which is responsible for policing, indicating closer ties between the panels and policy-making. Other Ministries, such as the Departments for Education and Employment and the Department of Health were involved in the second Foresight cycle from the outset, with others joining as the programme progressed.

The activities were supported and coordinated by the Office of Science and Technology, with a steering committee composed of representatives of government, industry, research and development and academia. The first cycle of the programme had been clearly under resourced (Wood 2001, p. 3). In the second cycle, panels tended to be rather smaller than in the first, and composed of individuals selected for their wide of view of the panel topic and their energy and drive to ensure that actions were implemented (ibid.) rather than on account of expertise. The panels had the mandate to set up task forces and associate programmes, which were run by organisations outside the OST on topics of particular interest to their membership, independ

ently from the main governmental programme. At least the materials panel concentrated on topics which tended to cut across disciplines and which did not fall squarely into the interests of an easily identifiable group of actors (cf. Wood, op.cit.). This had been a major recommendation of a review of the first cycle by the Parliamentary Office of Science and Technology (POST 1997).

An important job of the panel members was to support the activities of task forces and associate programmes, which required considerable effort from each panel member, at least initially. Due to the distributed nature of activities, a system of "branding" or quality control was installed to ensure an adequate standard of output under the "foresight" label.

The interactive element was stressed possibly more for the second cycle than for the first: the reports were regarded primarily as a vehicle to start a dialogue involving as large a community as possible, and there was a requirement that the panel reports should relate to each other "so that coherent messages and actions are identified" (Wood op.cit, p. 10).

All panels were asked to give consideration to two cross-sectional aspects, namely education, skills and training, and sustainable development. In addition, each panel had members intended to give special attention to the so-called "underpinning" technologies, information technology and biotechnology. Thus, the second cycle had more intentional links between the panels than the first.

While the chairpersons of the panels in the first UK foresight cycle had typically been the research directors of major companies, an attempt was made in the second cycle to involve company chairmen and chief executives. The panels were operated as strategic entities and formed task forces – over 50 in all – to address specific issues. Some of these task forces formed a link with the first foresight round by implementing the recommendations of the panels in the first cycle. Membership in the task groups was not restricted to panel members.

There was no Delphi survey in the second foresight cyclee, but there was a common resource, the "knowledge pool", a collection of data, information and complete documents designed to support and provide a common basis for work in the panels and their task groups. This pool initially contained results and other documents from past foresight activities in the UK and other countries, official reports relevant to science and technology policy from national, European and OECD sources. The pool was conceived as a professionally managed library available both on the internet and in hard copy. The existence and widespread availability of this pool was described as a major achievement of the second foresight cycle, both by participants (cf. Wood 2001) and the OST (2nd Whitehall Foresight Progress Report).

Some of the task forces were a direct result of the recommendations of the first cycle panels, in some cases even spanning the interests of more than one panel. The task forces were generally set up to explore specific issues identified as being of significance by the sectoral and thematic panels. Their major benefit was probably the involvement of an even greater constituency of stakeholders in the foresight programme.

A2.8.4 Method and Procedure

The panels each were required to produce an action plan in summer 1999. These plans outlined the necessary steps leading to the production of final reports by November 2000. Most panels produced and circulated consultation documents, partly drawn from the knowledge pool. These documents reflected the panels' initial ideas and proposals and were intended to be sounded

against the views of a broader constituency of stakeholders. Opportunities for this were provides through a variety of regional events, such as workshops and seminars. Drafts and other documents were posted on the programme's website for open consultation.

One of the shortcomings of the first UK foresight cycle was perceived to be its failure to substantially engage small and medium-sized enterprises (SMEs). This had been done during the closing stages by targeting intermediary organisations, such as trade associations. In the second cycle, support materials for such potential facilitators were made available early on in the process. The regional perspective was included by involving the Regional Development Agencies in the English Regions, Scotland, Northern Ireland and Wales. This was also seen as an important factor in reaching the SMEs.

In all, there were 160 workshops and seminars in the second cycle, not including panel and task force meetings. Additionally, there were 52 regional seminars. There were on average 46 500 website visits per month. A total of 103 papers and reports were published, including the main panel reports in December 2000. Membership in panels and task forces amounted to a total of over five hundred.

The second round of UK foresight was terminated prematurely due to changes at the Office of Science and Technology, principally a change in the office of Chief Scientist.

A2.8.5 IST in UK Foresight

In the second cycle of United Kingdom foresight, ISTs were treated as an underpinning technology by appointing two members to each thematic panel with special responsibilities for IT. There was also a sector panel on "Information, Communications and Media" (ICM panel). This panel had a number of sub-groups including one on "Information Technology, Electronics and Communications". The final report by the ICM panel entitled "Let's Get Digital", was published in December 2000. There was also a consultation document, "ITEC Technologies", by the ITEC group which is of particular interest in the present project, since it is concerned more specifically with technological developments. This document was intended for broad discussion and raised a number of questions, for which answers were invited from interested parties, such as stakeholders and other experts. Another document produced by this sub-group was on ITEC visions, which discussed key technologies applied in various areas of work and life in general.

A2.8.6 Other Important Results of UK Foresight

As stated previously, the second foresight cycle was stopped short when a new Chief Scientist took office in 2002. Since then, the foresight programme has focused on currently two, but up to four, topics per year.

The steering group did not publish any recommendations of its own, but a 15-page brochure describing some of the main messages. Individual reports have been criticised in parliament by the ministers responsible for the area, despite a mechanism put in place to ensure that products bearing the "foresight" stamp met at least an agreed standard. Despite the praise initially heaped on the knowledge pool, apparently little use was made of this resource. Overall, the second cycle had far less impact than the first (Ian Miles, personal communication 2003). This could be due to the extremely broad range of activities initiated under the "foresight" banner, which must have taxed the coordination skills of panel members, who were responsible for liaison with the task groups and the associate programmes and were fewer in number than in

the first cycle. Due to the premature end of the cycle, little has apparently been done to bring the results of the multifarious activities together in few, concise reports.

Since the second cycle was a continuation of the first, the achievements of UK foresight should also take into account the impact of the first round. The materials panel during the first cycle is said to have been a major driving force behind the acceptance in the UK of nanotechnology as one, if not the, key area of technology for the future. For example it has encouraged support for two Interdisciplinary Research Centres in nanotechnology. The creation of thirty-two Associate Programmes, undertaken by other organisations (mainly professional institutions and research and technology organisations) in support of the central programme may be interpreted as a measure of its widespread popularity and acceptance in the UK.

Inspired by the Foresight programme, the Department for Education and Science, Foresight has supported the Young Foresight initiative. This project is aimed at giving students direct experience in all the skills needed to create a successful product or service: from conceptualisation, to design, to adaptability in the market place.

The programme has had impact on governmental funding of projects run jointly by academia and industry through Foresight Challenge Awards, supporting twenty-four consortia and three rounds of Foresight LINK Awards (FLAs), involving funding of £29M to 39. Altogether, with industry support, these projects are worth a total of £152M.

Foresight activities have since been established at the level of the regions, so in total the UK Foresight programme would seem to have had very enduring effects.