# *Selection of research priorities – method of critical technologies*

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## ABSTRACT

The identification of strategic research priorities, having a high potential to contribute to a favourable economic development and to the fulfilment of social needs of the society, together with the optimum utilisation of limited public funds, is subject of many foresight studies. Different methods are applied to identify a limited set of national research priorities – this paper deals with method of critical technologies, which is widely used in several countries, e.g. United States, France and recently in the Czech Republic. The method consists of applying sets of criteria against which the "criticality" (importance) of particular technology (research direction) can be measured.

The paper summarises the basics of the critical technologies method and it brings an example of its recent applications in the Czech Republic in 2001. The main objective of the Czech exercise was to select priorities of the new National Research Programme, which should be launched in January 2004.

## BACKGROUND

The frequent basic objective of the national foresight exercises is to identify the most important technologies (research priorities) likely to be demanded by the national industry and the service sector over the certain period of time. Research conducted in defined priority areas should contribute to the achievement of strategic goals in the key sectors important for the national wealth creation and for the improvement of the quality of life of people.

Such technologies that are the driving forces in national economic prosperity and security are regarded as *critical* to national interests. Due to limits in R&D spending even in rich world economies, neither government nor industry can afford to invest in every possible field of research. For better guidance of R&D spending and for definition of priority research areas, a number of countries initiate a national foresight exercise aimed at identification of *national critical technologies* (or national key research directions).

Different countries developed different approach in identifying their *critical technologies list*. While most of European countries and Japan developed more or less sophisticated foresight exercises, in the United States much more straightforward effort was conducted in the decade between 1989 and 1999. Four National Critical Technologies Reports were produced so far using different methodology (special panel or industrial interviews conducted by an expert's organization). The last fourth report was prepared by RAND in 1998 [1].

In France, the Ministry of Industry initiated the last national exercise based on the critical-technologies principle in 1999. The exercise called "Technologies Clés 2005 (Key Technologies 2005) aimed at producing a list of around 100 technologies that could be considered to be critical (key) for French competitiveness [2].

The Czech Government decided to sponsor the first national technology foresight in 2001. The main objective of the exercise was to propose key research directions (critical technologies) having a strong potential to contribute to a favourable economic development and to the fulfilment of societal needs of the society while optimally using the public funds for research. The final report was published in in 2002 and it is also available on Internet [3].

The above examples of four countries do not represent an exhaustive list of using a method of critical technologies in foresight exercises. They should be understood as a demonstration of the method applicability in different countries as of the size and the type of economy.

## CRITICAL TECHNOLOGIES

In some languages, the word "critical" has a "catastrophic accent", therefore, the wording "key technologies" is used instead. Despite the name, the meaning is always the same – technologies having a strong potential to influence the national competitiveness and the quality of life. The method always involves an application of a specific set of criteria to measure "the criticality" of particular technologies.

### *What is a critical technology?*

Bimber and Popper declared in their recent paper [4] that for a technology three criteria should be met to be considered as a critical:

1. Policy-relevant – the produced list of technologies should also indicate where are the potential areas (issues) for political interventions to make results feasible. Particular attention should be paid to the issues of R&D processes, commercialisation, dissemination and utilization of results.
2. Discriminating – it should be clearly possible to distinguish between critical and non-critical technologies. It should not be acceptable to include any advanced (popular) technology. Particular attention should be paid to the level of aggregation of different technologies to avoid hiding of non-critical technologies under the "critical headline".
3. Reproducible – even those not directly participating in the exercise should be able to reconstruct the procedures used to select the critical technologies. The used method should be transparent, robust and publicly accessible.

The term of “critical technology” should not be mixed with other terms, like:

- state-of-the-art technologies – these technologies may lack policy relevance and sometimes they may be included in the list only because the exercise managers may hesitate not to include „a popular“ technology in the final list;
- technologies for national self-sufficiency – with rising globalisation there are many technologies (particularly in case of smaller countries) that are important for the country on the one hand but may be easily bought on the international market on the other.

On the other hand there are other types of technologies that would fit the criteria of criticality, for instance the generic and pre-competitive technologies. They are potentially useful in many applications, the technology is then considered to be critical because invested resources are believed to return in various product applications.

## METHOD OF CRITICAL TECHNOLOGIES

### *Objective*

The main objective is to prepare a list of critical technologies with a clear indication of related policy actions that should enable the implementation of results.

### *When is this method useful?*

Method of critical technologies is particularly useful in situations when straightforward “discrete” recommendations for discussion at the political level are the prime objective. In practice, the method of critical technologies is particularly useful for *setting national R&D priorities*. Specific questions then characterize the exercise:

- what are the key areas of R&D?
- what are the critical technologies (key research directions) that should be preferentially supported from (public) resources?
- what criteria should be applied to choose critical technologies?
- what are the most important measures that should be discussed at the policy level to enable implementation of results?

There is a tendency to extend the objectives from a “simple” technology prioritization to a broader assessment of the national innovation system. The exercises conducted recently in France and the Czech Republic are the examples of that trend [2], [3].

In principle, a method of critical technologies could be also used to identify “non-technology critical issues” for instance in social area but no example of such activity was published so far.

### *What are the potential weaknesses?*

The main danger could be a relatively narrow group of experts participating in the exercise. The method may further tend to focus exclusively on technologies without paying sufficient attention to other approaches (e.g. socio-economic). On the other hand, there are examples that exercises based on method of critical technologies can be designed and managed in such a way that both mentioned potential weaknesses are reasonably restricted.

## HOW TO CONDUCT THE EXERCISE?

There is no single recipe which could be generally considered as “the only one“ for any foresight exercise based on the method of critical technologies. The following paragraphs summarize some general suggestions that could be derived from foresight exercises conducted in the recent past. The case example in the following section provides more detailed suggestion how to conduct the foresight exercise using the principle of critical technologies. On the other hand, it is realistic to assume that the case studies can provide only basic suggestions while concrete methodology will always be dependent on particular tasks and objectives of the exercise.

### *Structure of the exercise*

Although a wide variety of patterns could be used for structuring the critical technology exercise, there are always some typical steps that are involved (Fig. 1)

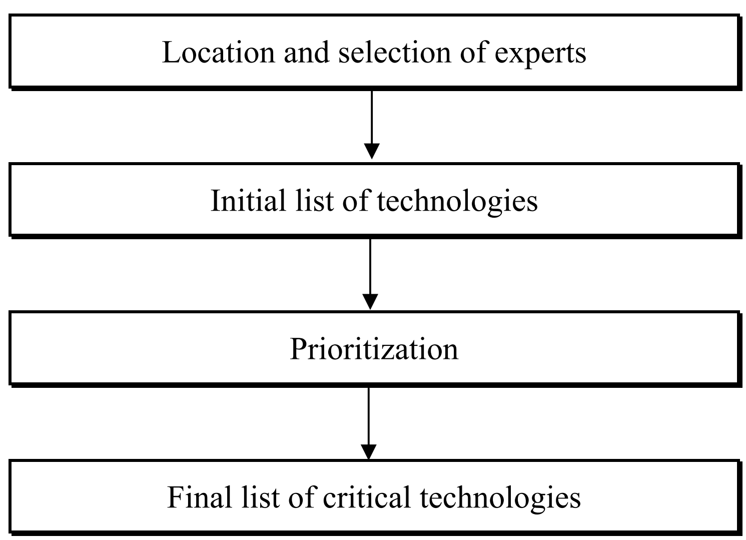


Fig. 1 – Typical steps of critical technologies exercise

Individual steps of a more detailed structure of a critical technologies exercise are discussed in the case example (Czech foresight exercise) in a subsequent section of this paper.

### *Location and selection of experts*

Location and selection of experts is a key initial step of any technology foresight. The method used for location of experts is profoundly influenced by the total extent of consultation scheme [6]. Two possibilities – (i) narrow consultation, and (ii) broad consultation are likely to cover any programme, although some mixed types are always possible.

Narrow consultation scheme is typical for most "expert committee studies" conducted for instance in the US programmes of critical technologies [1]. A relatively narrow group of experts is appointed by the exercise sponsor, the sponsor also prepares (initial) terms of reference. The expert committee uses dominantly own resources and scarcely seeks consulting capacities outside itself. The advantage is the speed and relatively low operational costs. On the other hand, the opinions are hardly unbiased because special interests in a small group are very likely.

Broad consulting scheme includes a central management group that co-ordinates and manages the whole exercise using amply an external expertise gathered in panels, expert groups, knowledge pools. The core group is responsible for finding and selection of experts.

### *Initial list of technologies*

Initial list of technologies can be derived from already existing lists (for instance from previous foresight studies) or it can be produced in brainstorming sessions or discussions of experts panels. Additionally, such approaches as bibliographic searches, expert studies, industrial interviews, environmental scanning may be combined to receive a comprehensive list to examine.

### *Prioritization procedure*

Prioritization is the most difficult and risky step of the exercise. The main objective sounds quite simply – to reduce the initial list of technologies considered to a list of critical technologies that are the most relevant against the set of criteria applied. However, because prioritization may discard a substantial number of technologies considered so far, there are suddenly "the winners" and "the losers". It is the point when strong lobbying is usually taking place and it is the one of the most important tasks for team managing the exercise to keep results protected against external pressures as much as possible.

In practice, usually a *voting procedure* is used to make a selection from the initial list of technologies. It should be noted that prioritization is not exclusively tied to the method of critical technologies. Practically all foresight techniques have to make some selection of priorities at certain point. In some programmes, for instance in the case of the UK foresight exercise [5], where a Delphi survey is used, an objective function is formally defined. The prioritization procedure is looking for a maximum of the objective function. In the UK exercise the prioritization is made by sorting the topics in descending order of indices representing the objective function. The objective functions chosen for the UK programme were the *wealth creation* and the *quality of life*. The following Tab.1 published by Loveridge [6] illustrates both variables in detail. Delphi respondents indicated the influence each Delphi topic would have on each objective function by selecting the appropriate number. The result then can be depicted in a two-dimensional graph with both objective functions as variables for each of the considered topics.

| Impact | Choice number | Wealth Creation | Quality of Life |
|---|---|---|---|
| Harmful | 1 | Development might be socially beneficial but economically detrimental | Development might be economically beneficial but socially detrimental |
| Neutral | 2 | It is likely to have only marginal effect on the UK's economy and on wealth creation | It affects the population or the environment in a minor way |
| Beneficial | 3 | Its realisation is likely to have a significant influence on the UK economy and may lead to new forms of wealth creation | It is beneficial to most of the population or the environment in a recognisable way. |
| Highly beneficial | 4 | It responds to a major market need or creates a revolutionary opportunity capable of market exploitation providing sustainable wealth creation | It is likely to provide a major advancement in the quality of life for most people and a substantial improvement for a minority of people in fields such as health, culture and in the environment. |

Tab.1 The objective functions for the UK foresight programme [6]

Another type of voting (prioritization) procedure follows the approach used by the Australian CSIRO [7] or by the United Nations University in the Millenium Project [8]. In this case, two parameters, *attractiveness* and *feasibility* (CSIRO) or *importance* and *likelihood* (Millenium Project) were used. Similar voting method using the later set of parameters was used in the Czech foresight exercise [3]. Again, the topics prioritized using this process need not to be necessarily obtained through a critical technology exercise but they may have emerged from any type of foresight process. The parameters *attractiveness* and *feasibility* are determined for each technology from the initial list. The technologies that have good scoring for *both parameters* are potential candidates for the final list of critical technologies. Both parameters have a complex character – they result from values of individual criteria that were assigned by voters to individual technologies from the initial list. The procedure leading to both parameters is schematically illustrated in the following Fig.3.

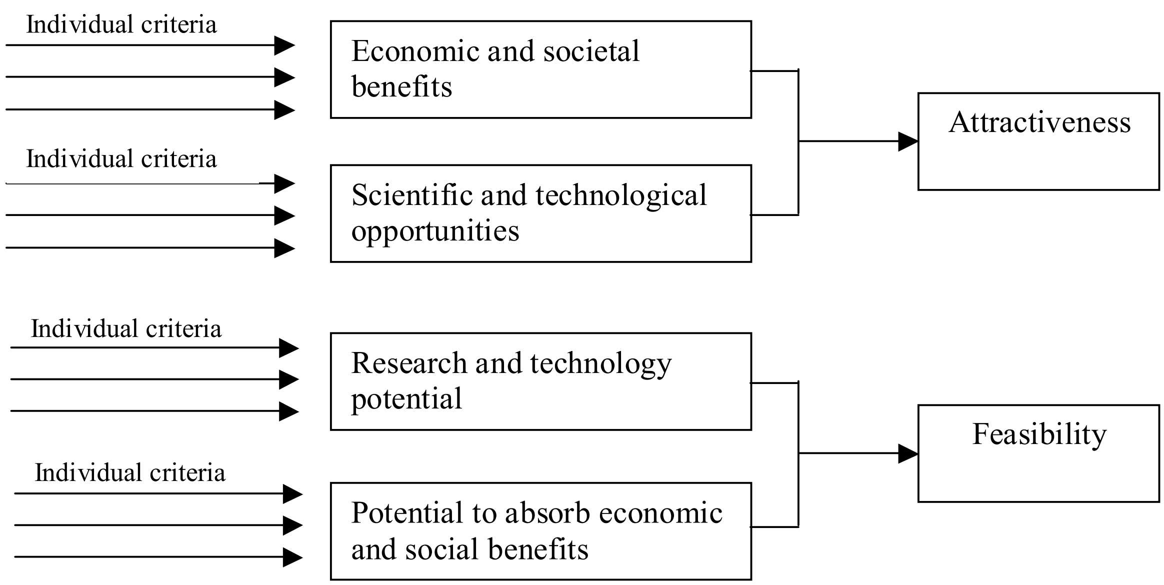


Fig.3 Scheme of prioritization

Individual criteria may have different form, usually they should say what benefits may be expected from new technology (or what economic or societal needs will be satisfied).For instance criteria for economic benefits could be formulated as "market growth", "contribution to productivity", for societal benefits there could be criteria "importance for human health", "impact on material/energy effectiveness". Criteria for research and technology potential may include "probability of breakthrough discoveries", "demand of the application sector" or "competitiveness of related industry".

Voters (e.g. members of panels) asses each of the technologies from initial list against agreed set of criteria through assigning a "mark" from the scale 1 (low), ..., 5 (extremely high) to each of the criteria for each specific technology. Individual marks are then clustered following the scheme in Fig.3. to receive two parameters – *"attractiveness"* and "*feasibility*". Situation could be further complicated using different weights for each criterion or introducing different level of expertise for each of the voting experts. The total number of received data may reach the value of several hundreds of thousands. Electronic voting procedures were developed to make the voting and handling large number of data feasible. Such attitude will be illustrated using the case example from the Czech exercise in a later section of this paper.

Once two parameters are received for each of considered technologies they may be used to represent graphically the ranking of individual technologies in a two-dimensional graph. An example of such presentation is in Fig. 4 below.

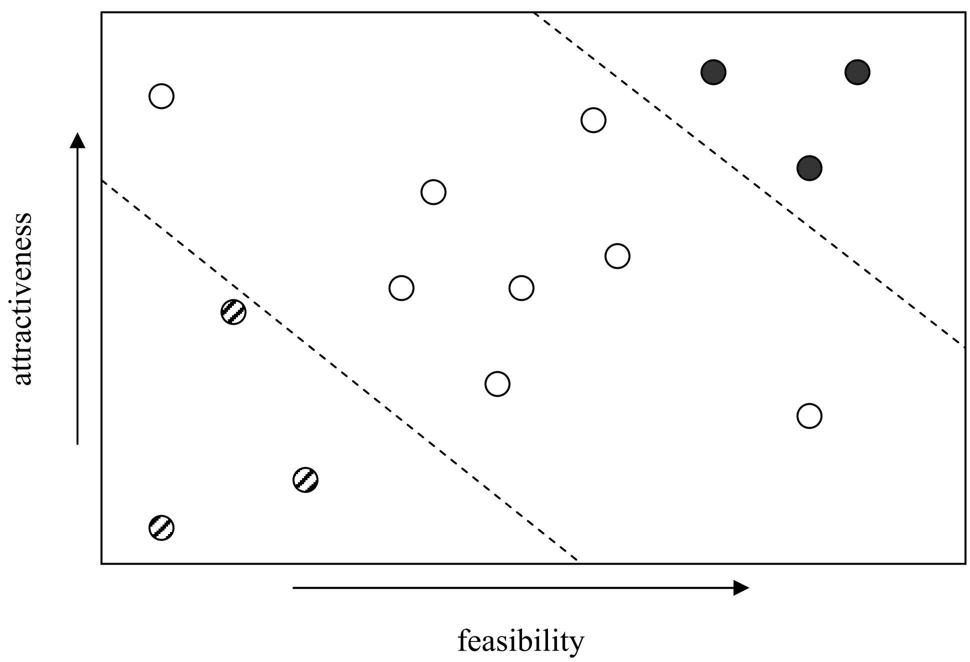


Fig.4 Ranking of technologies in the plane of parameters „attractiveness" and feasibility"

The points in the graph correspond to individual technologies. Black points in the upper right-hand corner are strong candidates for "critical technologies", the points in the lower left-hand corner correspond to less attractive technologies with low feasibility in considered environment (national economy, industry). A special attention deserves the point in the upper left-hand corner – the technology with very high attractiveness but very low feasibility. If such a technology is really highly attractive and important then group of experts should consider it as a good candidate for key technologies and recommend supporting measures that would increase the feasibility. The results of voting should not be accepted automatically as the final outcome of prioritization. They should be thoroughly discussed in an expert group to confirm results of voting and to identify possible pitfalls. It may happen that group of experts suggests to change the standing of some technologies moving them to a better (or a worse) position in the graph. However, in such a case, the project management should require a detailed justification otherwise the prioritization would lose the credibility.

### *Final list of critical technologies*

The final list of critical technologies is an essential part of the final report to the sponsor. It does not include the final decisions because they are at responsibility of policy makers but it brings important expert's message that should create a good background for political decisions.

The final list of critical technologies may be accompanied by "ID sheets" of suggested critical technologies which identify their main characteristics, application areas and critical problems to be addressed.

## CASE EXAMPLE – THE CZECH REPUBLIC

### *Background*

The example of the foresight exercise conducted in the Czech Republic in 2001 is presented in detail in this paper. The method of critical technologies used in Czech case provided a list of national research priorities for the new National Research Programme (NRP). The case example may be modified (replicated) in other countries that may need to select their research priorities in order to optimally use limited public resources for research.

### *The objective of the exercise*

The National R&D Policy approved by the Czech Government in 2000 declared the need of early identification of detailed priorities of research funded from public resources using some of the proven methodologies (or a combination of methodologies) of the technology foresight. The accomplishment of this task was the principal objective of the national technology foresight exercise conducted in the Czech Republic in 2001. Additionally, the exercise suggested some cross-cutting measures and it proposed a system of management principles and systemic instruments to make the new NRP operational.

***The managerial, advisory and executive structure***

The main project objectives may be achieved only through a co-operation within a relatively complex structure in which all the important stakeholders are represented. The basic structural elements of the Czech foresight project are illustrated in the Fig. 5. The dashed arrows indicate an advisory role.

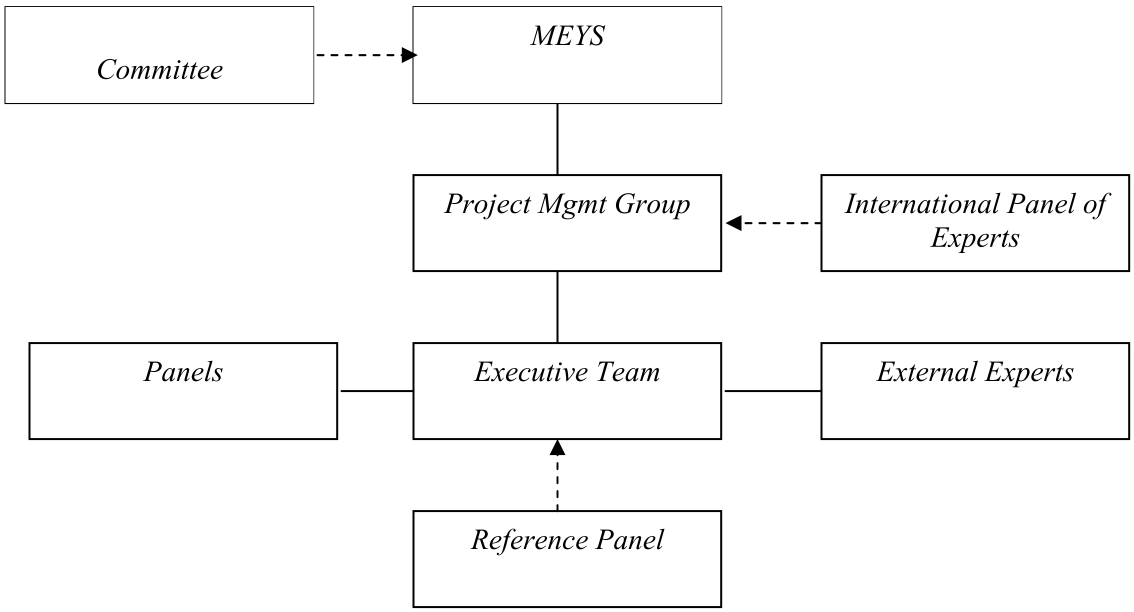


Fig. 5 – The structure of the Czech technology foresight project

*The Ministry of Education, Youth and Sports (MEYS)* was the project principal promoter and sponsor.

*The Co-ordination Committee* consisted of top representatives of key stakeholders – Governmental Departments (Ministries), research organizations, industry, political circles, business managers, market and social forecasters etc. The Committee was chaired by the Deputy Minister of the MEYS. The main task of the Committee was to evaluate the project progress, comment on its results, provide input on project modification and facilitate a broad consensus enabling the implementation of the project results.

*The Project Management Group* performed the executive management of the project. The Group was headed by the Project Manager who reported directly to the Ministry.

*Expert Panels* consisted typically of 15 – 20 leading national experts in a particular field. In each panel experts from research (providers of a new technology) and industry (users of a new technology) were evenly represented. The main panel outcomes were justified proposals of priority areas of oriented research including recommended measures for their implementation.

*The Executive Team* organized and supported the activities of Expert Panels, co-ordinated in-depth interviews of industrial managers and completed the quantitative analysis of significance of individual business sectors to the Czech economy.

*External experts* were the leading national professionals from particular business sectors. They were invited to prepare a SWOT analysis of their sector and suggest the priority fields of oriented research to match the needs identified in the analysis.

*International Panel of Experts* was a group of prominent international experts in the area of technology foresight. They provided their opinions on the project methodology and their views on the analysis and the interpretation of the results.

*Reference Panel* was created from representatives of research institutions, industrial companies, associations of entrepreneurs and other organizations. The panel included several tens of people who were electronically contacted about their opinion on interim project results. The opinion of the panel was considered in the formulation of final versions of project documents.

### *Location of experts*

In order to conduct the foresight project several hundreds of national experts were needed to participate in the panels and to perform independent analyses of application sectors. In the first phase of the project key national research institutions, universities, industrial companies, professional associations and other stakeholders were invited by MEYS to nominate experts for the foresight project. More than 500 names were submitted.

In the second step the nominees received a questionnaire with a brief description of the project objectives. The questionnaire was designed to elicit full contact details of respondents, their main areas of their professional involvement and a level of expertise in selected application sectors. The respondents were also asked to recommend other experts suitable for participation in the project. The new nominees were requested to repeat the whole procedure – so called co-nomination procedure used for instance in the UK Foresight Programme [5]. Finally, names and characteristics of more than 800 candidates were collected.

### *Preparatory phase*

Expert panels constituted a "creative backbone" of the project. The panels were provided with input information as a background for their efficient work from the beginning. The information consisted of three major components:

- *Results of interviews of the application sphere*. In-depth interviews (the demand side) of a representative sample of key companies from each application sector (286 companies in total) were conducted to identify the demand of users for results of oriented research. A structured questionnaire was designed for this purpose. In-depth interviews were performed during face-to-face meetings with company managers responsible for the R&D strategy. To ensure fully professional communication external experts were appointed to collect the data.

- *Results of desk research.* A thorough desk research was performed by the Executive Team to collect basic economic data and public research expenses in individual application sectors. The information was completed by abridged versions of sectoral strategic conceptions as prepared by individual Ministries.
- *Sectoral SWOT analyses*. Analyses were prepared by leading national experts for particular application sectors. Analyses included expected trends (scenarios) in the next 10 years.

***Panels***

Panels consisted typically of 15 – 20 leading national experts in a particular field. A chairman assisted by a panel secretary, who was also an expert in the particular field, chaired each panel. One of basic prerequisites for an efficient work of panels was to bring together people with different backgrounds and experience to combine professionals from the "supply -" and the "demand side".

After complex discussions with representatives of MEYS (project sponsor), Co-ordination Committee and other key stakeholders, 17 panels were established:

- 13 thematic panels:
  1. Agriculture and Food
  2. Environment
  3. Health Care and Pharmaceutics
  4. Information Society
  5. Building Industry, Urbanism and Housing
  6. Materials and Technology of Their Production
  7. Discrete Manufacturing
  8. Instruments and Devices
  9. Machinery and Equipment
  10. Chemical Products and Processes
  11. Transport Systems
  12. Energy and Raw Materials
  13. Social Transformation
- 3 cross-cutting panels:
  14. Human Resources for Research and Development
  15. Integrated Research and Development
  16. Regional and International Co-operation in Research and Development
- 1 systemic panel:
  17. Management and Implementation of the NRP

Because the scope of this paper – to illustrate the use of the method of critical technologies, only the work and outputs of *thematic panels* will be described further.

### ***Thematic panels' work and outputs***

First, the panels performed SWOT analyses of their respective application sectors. The results of the SWOT analyses were compared with the analyses previously elaborated by external experts. Panels were asked to identify *important research directions (IRDs)* using brainstorming followed by a repetitive discussion in each panel. The IRDs were assumed to have a potential to support an exploitation of the opportunities or to suppress the threats identified in SWOT analyses for each application sector with a maximum use of strengths of the corresponding research base and/or the relevant industry.

The number of IRDs identified by each panel varied from 15 to 64. In total, 612 IRDs were identified across the thirteen thematic panels using this approach. As the foresight exercise aimed at determining a rather narrow list of national research priorities, further reduction of IRDs was the next task for thematic panels.

The first reduction was made during discussions on the suggested 612 IRDs in panels. After formal rearrangements and elimination of IRDs with a very limited support by panels there were still almost six hundred of IRDs. Further reduction was carried out using a prioritisation procedure developed especially for the purpose of this foresight project. The procedure followed the approach used by the Australian CSIRO (Commonwealth Scientific & Industrial Research Organisation) [7].

During the prioritisation procedure the panel members evaluated each of the IRDs suggested in their panel against two parameters – *"importance"* and *"feasibility"*. Both parameters were obtained through assessment of individual IRDs against a set of 35 criteria (see Tab 2). The original set of criteria suggested by the Management Group was much shorter with an intention to reduce it even further. However, there had been much debate, with little room for compromise, particularly in the Co-ordination Committee. Criteria were grouped into six clusters, which were, in turn, aggregated into two parameters (co-ordinates) *"importance"* and *"feasibility"*. Due to a high number of criteria and IRDs and the number of voting panel members, a set of almost 300 thousand data was produced. The only feasible way of managing and evaluating such an amount of data consisted in using an electronic "voting procedure" developed specifically for this project and accessible to panel members (through a personal password) via Internet on the web site dedicated to this national foresight project. The opportunity to vote was open for about one month. A remarkable number of panel members (91%) voted, the resulting data was electronically processed and used for the first identification of reduced lists of IRDs. The obtained lists were further refined after a thorough discussion of voting results in each panel.

| IMPORTANCE | | | | FEASIBILITY | |
|---|---|---|---|---|---|
| Economic, Social and Environmental Importance | | | Research and Technological Opportunities | Application Potential (absorption potential of the application sector) | Research and Technology Potential (production potential of R&D) |
| Economic Importance | Social Importance | Environmental Importance | | | |
| importance for GDP | importance for human health | impact on material effectiveness | ability of the research direction to produce new technologies | competitiveness of the application sector(s) | current state of the art of the research field |
| importance for export | importance for the safety of the society | impact on energy effectiveness | probability of "breakthrough discoveries" | support in administration/state policy and regulation | probability of a positive development of the research field |
| impact on productivity | impact/influence on the quality of life | environmental-friendly effect | probability of creation of new application possibilities related to the research direction | availability of results in the world market | level of the necessary R&D infrastructure |
| market size | influence on the creation of job opportunities | potential of replacing unrenewable energy sources by renewable ones | possibility of combining the research direction with other research directions | demand of the application sector | financial requirements of the research direction |
| strategic importance for the Czech Republic internationally | | natural and productive space saving effect | possibility of applying the results of the research direction in various applications | influence on the creation and growth potential of small- and medium-sized enterprises | probability of financing from various sources |
| | | effect on transport requirements | probability of a synergic effect with other research directions | | level of education in related fields |
| | | | probability of involvement in international cooperation | | current quality of human resources |
| | | | importance for meeting untackled needs of the society | | |
| 5 | 4 | 6 | 8 | 5 | 7 |

Each criteria is to be assigned a mark from the scale of 1-5 : 1=low, 2=medium, 3=high, 4=very high, 5=extremely high

NOTE! For the shaded criteria the mark is reversed, i.e. 1=extremely high, 2=very high, 3=high, 4=medium, 5=low

Tab. 2 Criteria for selection of Key Research Directions (critical technologies) in Czech foresight exercise (2001)

A typical result of voting is illustrated in Fig. 6 (panel Information Society). Individual points correspond to the particular IRDs. The upper right-hand corner includes "key research directions". Panels were allowed to change in a few individual cases the standing of some IRDs, however, in such a case, the project management required a detailed justification.

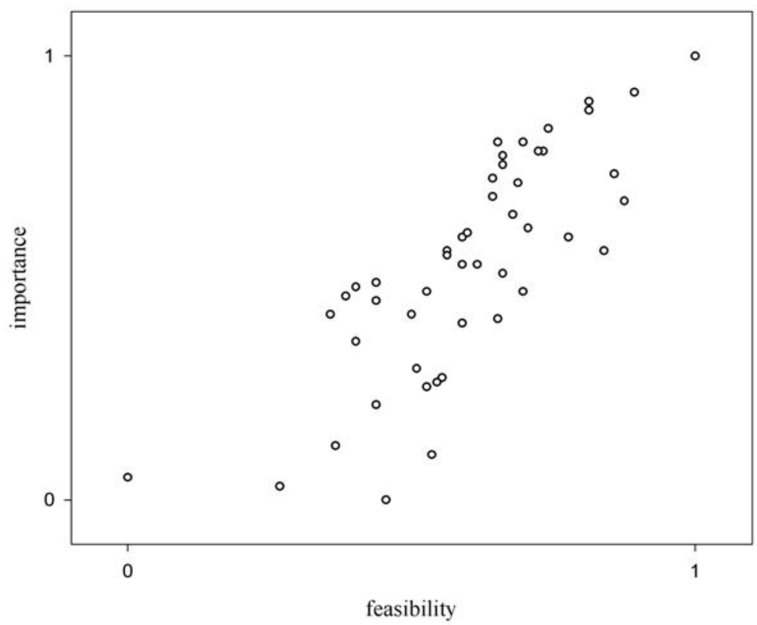


Fig. 6 – Results of voting – panel Information Society

The voting procedure and its discussion in thematic panels led to 163 *key research directions (KRDs)*, some of which resulted after aggregation of the original IRDs. The aggregation was possible because the original IRDs were very detailed and they sometimes covered only a narrow area of research. The leading principles of aggregation were thematic complementarities and links between IRDs. Some aggregations were made between IRDs suggested by different thematic panels as a result of communication between panels. The inter-panel communication addressed some cross-cutting issues, however, most of the cross-cutting issues in this foresight exercise were identified in the subsequent work of the Working Group (see the following section). The Working Group also carried out the second prioritisation, i.e. further reduction of the KRDs selected by panels.

The results of panels' work were summarised in their final reports. The reports contain comprehensive SWOT analyses of the particular application sectors, expected trends (brief scenarios), detailed description of the identification of IRDs and of the following prioritisation procedure. Each panel submitted the most important research directions as a list of KRDs (163 across the 13 panels), which were ranked consistently with their significance to the specific application sector. Additionally, most of the panels identified "emerging technologies" and "market niches" in their area of expertise. Some panels presented additional recommendations for the development of their particular R&D area and/or industry. Panels also prepared "ID sheets" of suggested KRDs which identify their main characteristics, application areas and critical problems to be addressed.

### *Working group*

A Working Group (WG) was established for the final phase of the project. The WG consisted of 17 panel chairpersons (13 for thematic panels, 3 for cross-cutting panels and 1 for the panel Management and Implementation of the NRP). Additionally, 1 person represented the pharmaceutical part of the panel Health Care and Pharmaceutics. The main reason for including panel members in the WG was the continuity with the previous stages and findings of the foresight exercise. The WG further included 8 members of the Co-ordination Committee – representatives of the sponsor, the R&D Council of the Czech Government and other key stakeholders. The main rationale for including these members was the recognition that the exercise moved closer to the implementation and, consequently, more "political" actors engaged in the project were necessary.

The main task of the WG was further selective reduction of the163 KRDs produced by panels. This step was inevitable because NPOR should result in national priorities and the research involved should thus receive a preferential financing. It was estimated that no more than 100 KRDs should constitute the final output of the foresight exercise.

The WG analysed the set of 163 KRDs suggested by panels. After the identification of cross-cutting themes and an extensive debate between representatives of panels the WG further reduced the total number of KRDs to the *final 90 KRDs*. The final list of KRDs is not presented in this concise paper, however, it is available with additional information on the Czech foresight exercise at www.foresight.cz .

## Conclusions

The method of critical technologies is very suitable for assessment of various technologies (or research directions) when selection of priorities is the major task of the foresight exercise. The outcomes of the exercise do not create final decisions but they formulate important recommendations of experts to policy makers. The method may tend to focus its attention dominantly on technology aspects while social dimensions may be neglected. A careful management of the exercise including a sophisticated design of priority criteria considering the social aspects may satisfactorily solve the problem.

## Literature

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