VİZYON 2023: TECHNOLOGY FORESIGHT FOR TURKEY

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____

Prof.Dr. Sencer Ayata
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

____

Assoc. Prof.Dr. Erkan Erdil
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

____

Assoc. Prof.Dr. Erkan Erdil
Supervisor

Examining Committee Members:

Dr. Barış Çakmur (METU, ADM) ___________________

Assoc. Prof.Dr. Erkan Erdil (METU, ECON) ___________________

Prof.Dr. Metin Durgut (METU, STPS) ___________________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Surname : Lütfiye Ziba Akkerman

Signature :

ABSTRACT

VİZYON 2023: TECHNOLOGY FORESIGHT FOR TURKEY

Akkerman, L. Ziba
M.S., Department of Science and Technology Policy Studies
Supervisor: Assoc. Prof.Dr. Erkan Erdil

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The aim of this thesis was to examine, describe and assess in detail the method, process, and outcome of the first national Turkish technology foresight study - Vizyon 2023 - and draw conclusions about its effect on the Turkish science, technology and innovation system. Technology foresight has gained widespread acceptance all over the world as a policy tool used in identifying future technologies, setting priorities, formulating science and technology policies and wiring up the national system of innovation. In this context, a review of the literature on technology foresight is undertaken and major concepts are established. The cases of the French and Hungarian technology foresights are examined in comparison to the Turkish technology foresight. Particular emphasis is given to describe the link to science and technology policy of the Vizyon 2023 technology foresight in order to assess its immediate and expected impacts. It is concluded that the Vizyon 2023 technology foresight was a carefully practiced study in line with current trends and knowledge, the linkage to policy was successful, but the result fell short in pointing to clear directions in terms of the implementation agenda. Furthermore, it is ascertained that the science and technology strategy formulated on the basis of the Vizyon 2023 Technology Foresight can only be successful, if implemented with the close coordination and collaboration of all actors of the national innovation system.

Keywords: Vizyon 2023, Technology Foresight, Turkish Technology Foresight, Science Technology Innovation Policy

ÖZ

VİZYON 2023: TÜRKİYE İÇİN TEKNOLOJİ ÖNGÖRÜSÜ

Akkerman, L. Ziba
Yüksek Lisans, Bilim ve Teknoloji Politikası Çalışmaları
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Bu çalışmanın amacı Türkiye'de ulusal düzeyde yapılan ilk teknoloji öngörüsü Vizyon 2023'ün yöntem, süreç ve sonuçlarını incelemek, tarif etmek, değerlendirmek ve Türk bilim, teknoloji ve yenilik sistemi üzerindeki etkilerine yönelik sonuçlar çıkarmaktır. Teknoloji öngörüsü tüm dünyada geleceğin teknolojilerini tanımak, öncelikleri belirlemek, bilim ve teknoloji politikaları tasarlamak ve ulusal yenilik sisteminin bağlantılarını oluşturmak amacıyla yaygın olarak kullanılan ve kabul edilen bir politika aracı olma özelliğini kazanmıştır. Bu çerçevede teknoloji öngörüsü ile ilgili bir literatür araştırması yapılmış ve önemli kavramlar tanımlanmıştır. Fransa ve Macaristan'da yapılan teknoloji öngörü çalışmaları Türkiye teknoloji öngörüsü ile karşılaştırmalı olarak incelenmiştir. Çalışmada, Türkiye teknoloji öngörüsünün yakın ve beklenen etkilerinin değerlendirilebilmesi amacıyla bilim ve teknoloji politikasıyla olan bağlantısının tanımlanmasına ağırlık verilmiştir. Vizyon 2023 teknoloji öngörüsünün güncel eğilim ve bilgiler doğrultusunda özenle uygulanmış bir çalışma olduğu, politika bağlantısının başarıyla gerçekleştirildiği ancak öngörü sonucunun uygulama gündemi açısından belirgin yönleri işaret etmekte zayıf kaldığı sonucuna varılmıştır. Ayrıca, Vizyon 2023 Teknoloji Öngörüsü'nü temel alarak oluşturulan bilim ve teknoloji stratejisinin, ulusal yenilik sistemindeki tüm aktörlerin eşgüdüm ve işbirliğinin sağlanması ile başarıya ulaşabileceğine dikkat çekilmektedir.

Anahtar Sözcükler: Vizyon 2023, Teknoloji Öngörüsü, Türkiye Teknoloji Öngörüsü, Bilim Teknoloji Yenilik Politikası

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CHAPTER I

INTRODUCTION

In the year 2002, the Scientific and Technical Research Council of Turkey (TÜBİTAK) gave start to the 'Vizyon 2023' project. The major theme of the Vizyon 2023 Project, was to create a welfare society that

- dominates in science and technology,
- has the awareness of using technology and is capable of producing new technologies,
- has the ability to convert technological progress to social and economic benefit,

in line with Atatürk's goal to reach the contemporary level of civilization by the year 2023, the 100th anniversary of the Republic (TÜBİTAK, 2004c, p. 11). In December 2001, Turkey's foremost authority of science and technology policy, the Supreme Council of Science and Technology (BTYK), had commissioned TÜBİTAK, to implement the Vizyon 2023 project, with the explicit purpose to use the results as the basis of a new long term science and technology policy for Turkey. Assessments made so far were revealing that Turkey's standing in terms of her ability to generate knowledge and utilize it for socio-economic development was not yet at a desired level.

The statement of 'raising the Turkish culture above the the contemporary level of civilization' had been pronounced by Mustafa Kemal Atatürk, the founder of the Republic of Turkey, on October 29th 1933, while delivering his famous speech for the 10th anniversary of the declaration of the republic. Atatürk's vision has so often been referred to later on, in so many diverse contexts and occasions, that it was deprived of its importance as a vision and became a cliché statement. In the same speech, Atatürk had further explained that it will be by virtue of the 'positive sciences' that this vision is realized. He had also noted that the time frame for the achievements under this vision should not be understood in accordance with the lethargic mentality of the past centuries, but be adjusted to the speed of action of the present century.

In accordance with the decisions of the BTYK of December 2001 the Vizyon 2023 project involved Turkey's first national technology foresight exercise, together with three other sub-projects aimed at collecting and evaluating data on the science, technology and human resources bases of the country. The four sub-projects under Vizyon 2023 were 'Technology Foresight', 'Technology Inventory', 'Research and Development (R&D) Human Resources' and 'R&D Infrastructure'.

The technology foresight project comprised the backbone of Vizyon 2023 and was successfully concluded. A resulting strategy document that included Turkey's science and technology vision, strategic technologies and R&D priorities and policy recommendations was presented to the BTYK on its 10th meeting in September 2004. The technology foresight exercise is, as the participative nature of the methods used mandates, well documented. On the other hand, only scarce information is available about the other three sub-projects and their contribution to Vizyon 2023.

Technology foresight is a policy tool that can be used to match future needs of societies with the supply of science and technology. The aim of technology foresight is to identify the possible futures with respect to technological development. The aim of technology policy, on the other hand, is to select a preferable future and facilitate its realization. While some form of assessment of the future has always been a prevailing matter, technology foresights have gained increasing popularity in the 1990's and many countries have engaged in national foresight projects from then on.

The available literature on technology foresight suggests that there are various strands in examining technology foresight activities. The first strand deals with methodology and the foresight process. A second strand concentrates on the study of cases on national, regional or organizational level. A third strand questions foresight as a policy tool and focuses on policy questions and implications.

Taking a mixed approach but emphasizing the role of technology foresight as a policy tool, this thesis is concerned with the first Turkish national technology foresight exercise. It is commonly agreed upon that the process benefits of foresight exercises are as important as the results obtained in terms of critical technology lists and policy statements. Acknowledging the significance of process benefits, this thesis investigates the Turkish technology foresight project in terms of its outcomes and the guidelines it has produced. We will examine whether the results of the foresight exercise have been converted to policy and implementation that may lead to an improvement of Turkey's standing in science, technology and innovation. As an attempt to search for an answer to these questions, we will proceed as follows: In chapter II, we undertake a review of the mainstream literature on technology foresight. We analyze major concepts related to foresight and science and technology policy, provide the definition of technology foresight and examine why policy, academia and business are in need of foresight. We then establish the significance of foresight as a policy tool for wiring up the national innovation system and proceed to investigate major elements of foresight methodology. Chapter III deals with international evidence on foresight in action. Here, we will review two major national foresight studies - the French and the Hungarian cases which are representative of different foresight approaches. These cases are deemed significant in respect to their distance to the Turkish foresight study. Chapter IV is devoted to the Turkish case. We first look at Turkey's science and technology policy history to gain a better understanding of the significance of Vizyon 2023. We then carry out a detailed examination of the Turkish foresight process. Our aim is to re-discover the route that leads from the output of the panels, the Delphi survey and the strategic technology groups' work to the Vizyon 2023 strategy document. We will describe the foresight process in detail and present the results in what we hope a more comprehensive way than present in the TÜBİTAK documentation, by mainly outlining them in tables. We will further follow the developments in Turkey's S&T system by examining the BTYK decisions that were taken after the foresight and strategy formulation process to demonstrate the immediate effect of the foresight. In Chapter V we will first analyze the strengths and weaknesses of the Turkish technology foresight study and then provide some policy recommendations.

It is obvious that overall, the technology foresight project under Vizyon 2023 represents ambitious effort and carefully executed work along the lines of current trends and knowledge. The understanding of the author of this thesis is that no matter how perfect the methods used, no matter how elaborate reports and policy documents are produced, the benefit of foresight will remain minimal unless concrete and sound action is taken. In other words, usefulness is more important than correctness. Execution is the determining factor of any kind of success, and execution depends not only on sound strategies and plans and duly allocated resources that set the implementation schedule, but also on the recognition of and commitment to the policy produced by all actors of the national innovation system. It will be argued that it is a common fallacy to confuse policy or objectives with strategy and plans, a fallacy that is also inherent in the Turkish Case. Foresight is not an end but a means to an end. Foresight is neither policy, nor strategy but may help devising policies and elaborating strategies. The linkage of foresight processes and the follow-up implementation of strategy and action poses a major difficulty. Yet, a successful link to policy does not guarantee successful implementation. It will therefore be investigated to what extend the Vizyon 2023 Technology foresight was able to inform and assist policy, decision making, planning and implementation to date in the Turkish case.

CHAPTER II

AN OVERVIEW OF TECHNOLOGY FORESIGHT

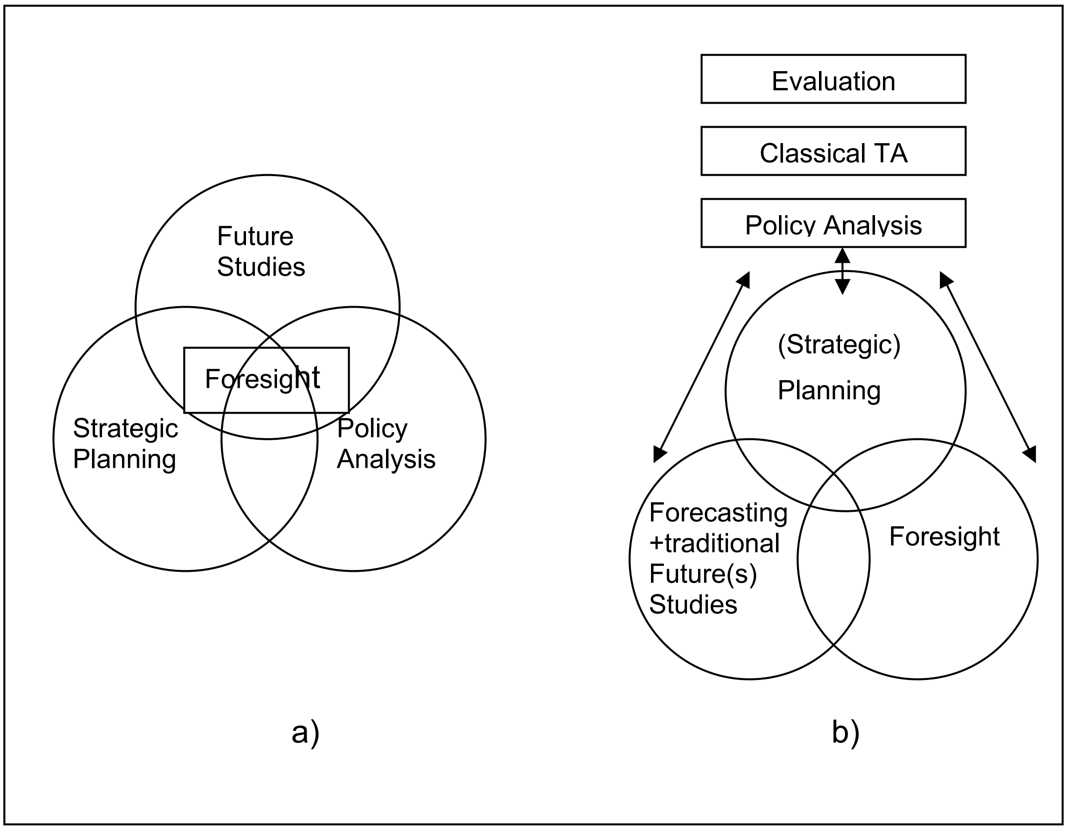
The European Union (EU) supported Foresight for Regional Development Network (FOREN) defines foresight as:

> …a systematic, participatory, future-intelligence-gathering and medium-to- long term vision-building process aimed at present-day decisions and mobilizing joint actions. Foresight arises from a convergence of trends underlying recent developments in the fields of 'policy analysis', 'strategic planning' and 'future studies'. It brings together key agents of change and various sources of knowledge in order to develop strategic visions and anticipatory intelligence (FOREN, 2001, p. V).

In order to gain a better understanding of technology foresight then, we first need to examine it in conjunction with the broader fields of future studies, strategic planning and policy analysis. We also need to look at the concepts of forecasting, foresight and planning by themselves and in relation to each other. It should however be noted that a general consensus on the definition of these terms does not exist, nor is there agreement about their proper use, boundaries and overlaps. While the above definition suggests that foresight is somewhere at the intersection of policy analysis', 'strategic planning' and 'future studies' (Figure 2.1a), Cuhls (2003), depicts foresight as a separate field (Figure 2.1b).

2.1 Future Studies

Future Studies is a field of inquiry involving systematic thinking about alternative futures. Future Studies is sometimes also referred to as futures research, futures analysis, futuristics, forecasting, futurology, prognostics, futurics and futuribles (Bell, 2003, p.70). While future studies is the term that most American futurists prefer, 'prospective studies' or 'prospective' is generally accepted in Europe to label this specific field of study. However, 'prospective' is more often taken to refer to 'foresight', rather than 'future studies' or 'forecasting' in Europe. In general, there are also some differences in conception and methodology between the two cultural worlds and futurists often tend to rely on their own intellectual roots and heritage. The need for more multicultural and multi-perspective work is often drawn to attention.



Source a) FOREN (2001), b), Cuhls (2003)

Figure 2.1: Models of Foresight in Relation to Other Fields.

Bell (2003) in his pioneering study, traces back its origins to the 1920's and 1930's. Bell particularly mentions the work of sociologist William F. Ogburn who, in service for the U.S. National Resources Committee helped to shape the report 'Technological Trends and National Policy, Including the Social Implications of New Inventions'. Ogburn's method included forecasting the future by quantitatively determining long-term trends concerning the past and then projecting them into the future for a number of decades (Bell, 2003, p. 8). Today, Ogburn's work is considered as the foundation of Technology Assessment (TA). TA is a standard approach to futures research based on the study and evaluation of new technologies, with the concern that new developments in technology will have socio-economic impacts and thus ethical and legal implications. TA was institutionalized in a variety of organizations such as the U.S. Congress's Office of Technology Assessment, Office of Technology Assessment at the German Parliament (TAB), and European Parliamentary Technology Assessment Network (EPTA). The Partners in EPTA are bodies performing science and technology assessment studies in order to advise parliaments on the possible social, economic and environmental impact of new sciences and technologies. Such work is seen as an aid to the democratic control of scientific and technological innovations (EPTA, 2006).

By the 1950's, France was an incubator of the modern futurist movement. Particularly to mention would be the contributions of Gaston Berger, Pierre Masse and Bertrand de Jouvenal. Jouvenal's 1964 book, 'The Art of Conjecture' is considered as a key work in the development of modern future studies where the emerging field is linked to the practical tasks of both short term and long-term planning (Bell, 2003, p. 21).

Bell (2003) defines the purpose of future studies as:

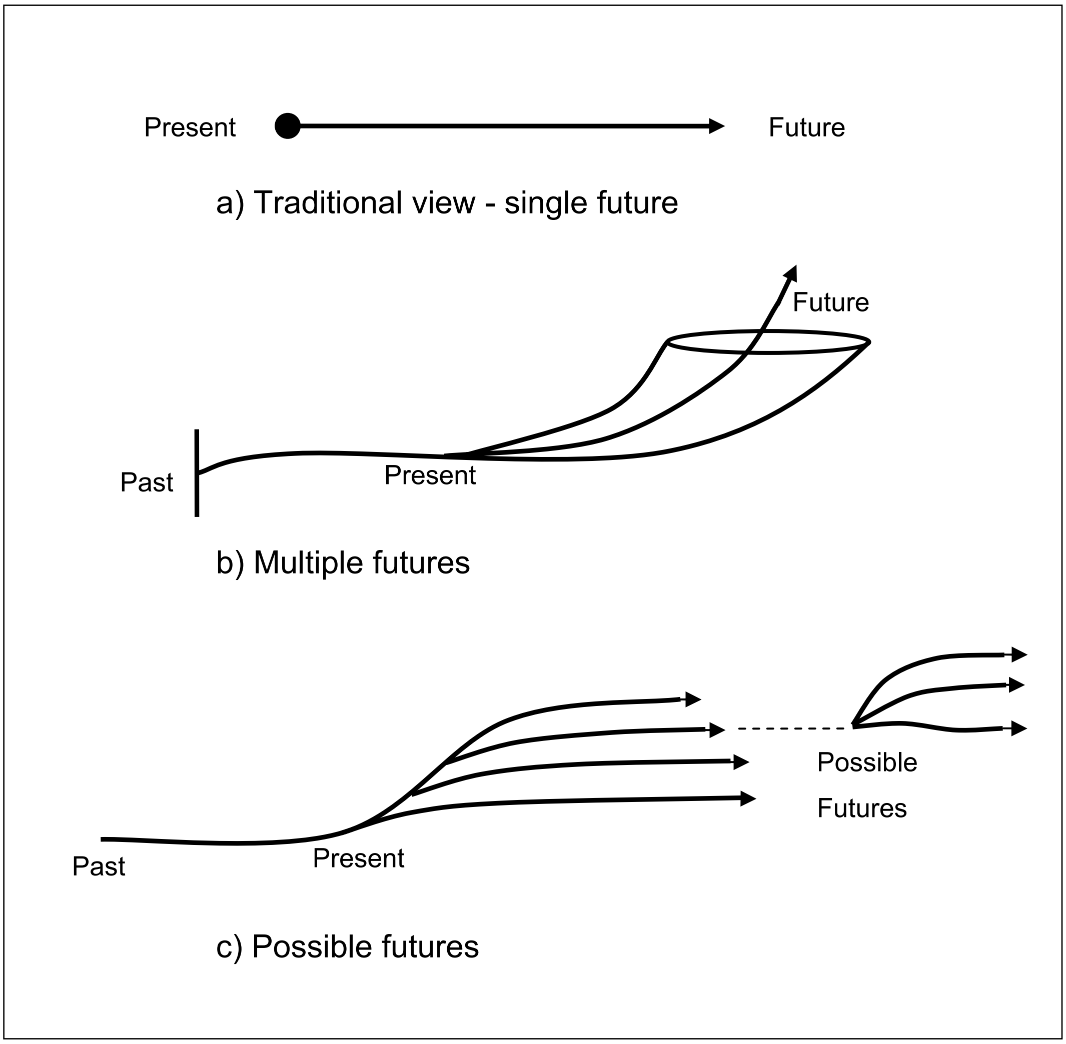
> to discover or invent, examine and evaluate, and propose possible, probable and preferable futures. Futurists seek to know: what can or could be (the possible), what is likely to be (the probable) and what ought to be (the preferable) (Bell, 2003, p. 73).

The ultimate purpose, however, is to aid making the decisions and guiding the actions of the present. As the consequences of decision-making and human action always occur in the future, future studies can be accurately described as an 'action science' (Bell, 2003, p. xxx).

The principal assumption of futures studies, then, is a notion of 'alternative futures'. Futures studies is often understood to be equivalent or closely related to ‘forecasting’. In many texts forecasting is the exploration of a specific future chosen amongst many alternatives; predicting what the future will look like usually by means of extrapolating trends. The definitions of forecasting may vary to some extent; nevertheless, there is one common underlying view of the future: The future is unknown, but the broad, general directions can be predicted and reasonably dealt with.

Thinking about the future, predicting what the future may bring is not new but has a long history. In every known society, people have conceptions of time and future. Historically, there was the belief of only one possible future usually depicted as an arrow pointing from the present to the future (Figure 2.2 a). This perception leads to a passive attitude towards the future and as Godet (1994, p.30) points out, is a legacy of religious fatalism. The future is seen as pre-determined, having already been written by the hand of god, so that human have no alternatives but submit to destiny. For Godet (1994), people started realizing the inevitability of change only after the industrial revolution and the sharp acceleration in scientific and technological progress in the twentieth century. This led to the opinion that, whether the future was predetermined or not, it may be predictable. Anticipating and preparing for the future would allow taking advantage of the opportunities that it offered. An adaptive attitude toward the future, thus, developed as a reaction to rapid change, accompanied by development in economic, technological and social forecasting, with mathematical models and methods as a means of predicting the future.

A different approach is to admit the possibility of multiple futures (Figures 2.2b and 2.2c) and that the future is not predetermined or simply an extension of the past but can be actively shaped by today’s actions. This is also the philosophical starting-point of ‘foresight’ or ‘prospective’. Godet (1994) sees at the root of all ‘prospective’ the assumption of freedom in the face of multiple and indeterminate futures. For Godet (1994), prospective is not the same as forecasting, which is too greatly affected by quantification and extrapolation of trends. Prospective does not see the future as simply a continuation of the past, because the future is open to the games of many players, who are acting today in accordance with their plans for the future. Therefore, “prospective is a way of thinking which throws light on present action by looking at possible futures” (Godet, 1994, p. 31).



Sources: a) Cuhls (2003), b) Godet (1994) c) Godet (1994)

Figure 2.2: Different Conceptions of the Future

The notion of actively shaping the future was first formulated by ‘operations research’ a discipline born in World War II (Cuhls, 2003). Operations research, thus, produced another strand in the development of future studies. The essential characteristics of operations research is to take a systems approach to problems with the basic aim to improve the functioning of the system by locating the variables that effect the performance and that can be manipulated by management (Bell, 2003, p. 30). During World War II, operations research was relied upon in military practice. After World War II, the U.S military initiated project RAND (An acronym for Research and Development) in order to enable operational researchers continue working together on future military technology. RAND lateron developed into a think tank and is known to have made important contributions to futures research, among others, the Delphi Survey technique and scenarios analysis that will be covered in Sections 2.4.2.1 and 2.4.2.2. RAND researchers Kahn, Helmer and Gordon need to be mentioned for their sometimes controversial contribution to features research mainly in the 1960's (Bell, 2003; Cuhls 2003).

Even though first attempts of scenario approaches were underway in the 1960's, most of the futures research done in this era still concentrated on the explanation of a single future that scientists had filtered out as probable or preferable. That the future was actually unpredictable became once again evident with the oil crises in 1973. As a matter of fact, the crisis was foreseen as a scenario option by the Shell Company, but this did not come to the attention of the wider public. Cuhls (2003) notes that thereafter, the disappointment of the unforeseen crisis caused a decrease in the interest in longer-term forecasting. In Godet's words, the year 1973 marked a turning point at which the future ceased to resemble the past, making the need for prospective analysis more immediate. Godet associates such breakdowns with new behavior patterns and notes that models based on past data and relationships are powerless as predictors (Godet, 1994, p. 30). Although not mentioned directly in conjunction with the oil crises, the shrinking interest in futures research especially in the private sector in the 1980's is also acknowledged by Bell (2003, p. 62). According to Cuhls (2003), the revival of the field and its regaining the reputation of decision makers in the governmental and public administration sector in Europe took place in the 1990's but with the changed label of 'foresight'. However, it should be noted that the difference of forecasting and foresight is not simply confined to a difference of wording as will be explained in the following sections. Futurists use a range of methodologies, not only quantitative ones such as time series, simulation, computer modeling but also more qualitative methods such as Delphi surveys and scenarios.

2.2 Policy Analysis

As reported by Ulrich (2002), a policy, according to the Oxford English Dictionary, is “a course or principle of action adopted or proposed by a government, party, business, or individual”. In accordance with this definition, the specific function of policies is to provide general directives rather than detailed instructions for action. Policies provide normative orientation – guiding values and ends – for the elaboration of strategies, programs and plans, which are more concerned with the selection of appropriate means for achieving those ends (Ulrich, 2002). Policy Analysis is a field of professional practice that is concerned with the scientific analysis of the contents and consequences of policies, particularly in public sector management and planning (Ulrich, 2002). Although there is no sharp distinction of labels, policy analysis is related to fields such as ‘policy science’ and ‘policy evaluation’. Policy analysis makes use of research and expertise in the process of public policymaking, whereby practical concerns of policy advising prevail. Explaining the policy process on a theoretical basis on the other hand, is the subject of the political and administrative sciences. Ulrich claims that the term ‘policy sciences’ offers itself as a concept that includes both concerns (Ulrich, 2002).

Lerner and Lasswell are generally credited with having laid out the framework of policy analysis (Bell, 2003, p. 53, Ulrich, 2002). Bell (2003) also lists Lasswell, who understood that the decisions of today inevitably bear implications for the future, as one of the contemporary pioneers of future studies (Bell, 2003, p. 51). Obviously, choosing among policy alternatives, deciding how to act, is at the same time a process of building and visualizing images of alternative futures and selecting from them. But, there is a major difference of understanding of policy science and future studies. Future studies seek to emphasize the possibility of alternative futures and the freedom vis-à-vis those alternative futures, for the purpose of empowering people to actively shape the future. The uncertainty of the future is regarded as a virtue. Policy science on the other hand aims to eliminate the uncertainty of the future through technology, law, policy and insurance. Policy science considers increasing the security of the future, by formulating and implementing policies, as the virtue (Bell, 2003, p. 56).

As shown in Table 2.1, the object domain of policy analysis can be listed under the three headings of policy formulation, policy implementation and policy review.

Table 2.1: The Object-Domain of Public Policy Analysis

I – POLICY FORMULATION
1 – Policy problems
2 – Policy objectives
3 –Policy contents (action plans and resources)
II – POLICY IMPLEMENTATION
4 – Policy decisions and legislation
5 – Policy implementation
6 – Policy outcomes and impacts
III – POLICY REVIEW
7 – Policy monitoring
8 – Policy evaluation
9 – Policy reporting

Source: Ulrich (2002)

Having this wide scope and being an interdisciplinary field, policy analysis has an equally broad methodological basis. Among others, decision analysis, sensitivity analysis, systems analysis, cost-benefit analysis, implementation research, financial auditing and reporting tools, evaluation research, environmental and social impact assessment, project management, social indicators, management information and reporting systems, total quality management, technology assessment, forecasting, scenario writing, creativity techniques and idealised design are tools used in policy analysis (Ulrich, 2002). Technology foresight itself may be deemed as a policy tool, as we shall establish in the next sections.

Before concluding this part, a few words need to be said on 'Evaluation Research', which is listed above as a policy analysis tool. Evaluation Research originally used to look backwards in order to determine the outcomes of specific policy implementations, to find out whether goals have been met and to specify who or what were responsible for the success or the failures. It is today part of the policy process, and evaluation is often carried out during program implementation to decide whether a program should be continued or replicated. In other words, evaluation research now looks forward and an evaluation of a particular project has its greatest implications for projects that will be put in place in the future (Bell, 2003, p. 58).

2.3 Strategic Planning

While policy analysis is more concerned with the public domain, strategic planning is a field of knowledge that targets corporate and organizational practice. Strategic planning arrived on the scene in the mid 1960's (Mintzberg, 1994). Some of the most influential contributors to the literature are Alfred Chandler, Igor Ansoff, Peter Drucker, Michael Porter, Gary Hamel, C.K. Prahalad and Henry Mintzberg. Again, there is no clear-cut definition of concepts and much ambiguity around terms such as 'strategic planning', 'strategic programming', 'strategic management', 'strategic leadership', 'strategic thinking' and even 'strategic prospective' and 'strategic learning' exists in the literature. The fields' progression over time can be traced back as one from 'long range planning' to 'strategic planning' in the 1960's, from 'strategic planning' to 'strategic management' in the 1980's and from 'strategic management' to 'strategic leadership' in the 1990's (Taylor, 1997).

There are various definitions for 'strategy' and 'planning'. For instance Goodstein et al. define strategy as "a coherent, unifying and integrative pattern of decisions" (Goodstein et al., 1993). In order to bypass a deeper conceptual debate we will simply refer to Godet (1994), who reminds that most modern concepts in strategy arise out of a military context, have a long history and going back to the basics is necessary for keeping clarity:

"The aim of strategy is to attain the objectives set by policy, by making the best use of the means at one's disposal" and, (citing L. Boyer and N. Equilbey) "management is the art of placing the organization at the service of strategy". Consequently, the term 'strategic management' is almost a pleonasm for Godet, since management is by definition, at the service of strategy (Godet, 1994, p. 208). Yet, strategic management is a well established field and its fundamental question is how firms achieve and sustain competitive advantage (Teece et al., 1997).

Ackoff (1981) defines planning as "anticipatory decision making"; "a process of deciding before action is required". Adding the word 'strategic' to 'planning' expands its meaning to include 'target building' (Cuhls, 2003), which is also reflected in the following definitions:

> Strategic planning involves creating a vision of the business the company is in or wants to be in, setting the company's goals and determining resource allocation and other actions to pursue those goals. The successful result of strategic planning usually is seen as maneuvering the company over the long run into the product and market positions and to the profitability levels desired vis-a`-vis competitors (Scott, 2001).

"Formal strategic planning is the process of determining the mission, major objectives, strategies and policies that govern the acquisition and allocation of resources to achieve organizational aim" (Pearce et al., 1987). Here, the term 'formal strategic planning' is used in order to convey that the strategic planning process involves explicit systematic procedures used to gain the involvement and commitment of those principal stakeholders affected by the 'plan' (Glaister and Falshaw, 1999). In order to link long-range goals with both mid-range and operational plans, it is necessary to forecast, model and construct alternative future scenarios. Standard strategic planning approaches furthermore incorporate an external environmental analysis to identify the opportunities and threats facing the organization, and an internal analysis to identity the organization's strengths and weaknesses. This is called SWOT (strengths, weaknesses, opportunities and threats) analysis and is frequently used as a strategic planning tool. SWOT analysis may itself encompass a number of different forms of analysis, for example, an examination of the industry structure and an assessment of the resource base of the organization as well as the identification of core competencies (Glaister and Falshaw, 1999).

Be it called strategic or not, the result of planning is always something pragmatic: 'the plan' (Cuhls, 2003). The operative plan for instance includes tasks, measurable objectives and milestones to be achieved (Goodstein et al., 1993).

Strategic Planning was regarded for more than a decade as the best way to devise strategies and to formulate step by step instructions for carrying out those strategies with the ultimate aim to enhance competitiveness of business units. By the end of the 1970's, however, strategic planning has suffered substantial loss in popularity and influence. It had become apparent that formal planning systems contributed little or nothing to the adaptability and flexibility of organizations, abilities that are needed in order to deal with permanent change in a competitive environment. The loss of confidence in strategic planning led many companies to lay off their planners (Glaister and Falshaw, 1999).

One of the fiercest critiques of strategic planning belongs to Mintzberg (1994). In 'The Fall and Rise of Strategic Planning' Mintzberg (1994) argued that "planners shouldn't create strategies, but they can supply data, help managers think strategically, and program the vision". Mintzberg's argument rests on his idea that the most successful strategies are visions, not plans. Planning has always been about analysis, about breaking up a goal into steps and formalizing those steps. Strategy formulation on the other hand is about synthesis and involves intuition and creativity. Therefore, the strategy formulation process must emphasize informal learning and personal vision. Strategic Planning is prone by many fallacies one of them being the 'fallacy of prediction'. For Mintzberg (1994), it is impossible to forecast discontinuities such as technological innovation or a price increase. He emphasizes the role of 'visionaries', individuals who see such change coming. However, this does not lead to the conclusion that planning (or 'programming' in Mintzberg's terminology) is unnecessary. Rather, it is important to acknowledge that strategic planning is no substitute for strategic thinking (Mintzberg, 1994).

Despite the critiques of Mintzberg and others, strategy has regained some of the reputation and influence that it had previously lost during the 1990s (Glaister and Falshaw, 1999). In defense of strategic planning, Godet (2000) points out that no matter how temporary managerial fads may be, they serve the task of getting people involved and motivated through new challenges. The real difficulty lies in making sure that all the participants ask themselves the right questions, rather than making the right choices. Defining the problem correctly and sharing it with all people concerned, is half way to a solution. In this way, strategic analysis can generate a synthesis of collective commitment (Godet, 2000).

There are many methods that originate from strategic planning and are frequently used in the context of foresight processes, such as the definition of vision and mission statements, scenarios planning and SWOT analysis. Likewise, critiques such as those brought by Mintzberg equally apply to and can as well be considered in the context of foresight.

2.4 Foresight

Having examined the related fields of future studies, policy analysis and strategic planning, we now may look at foresight, which occupies the space in which these disciplines overlap. But, foresight is not about academic or consultancy-based forecasts of the future, it is not planning, it does not define policy, nor does it displace existing decision-making and planning processes (FOREN, 2001, p. 5). Foresight may take forecasts into account and foresight results can serve as an input to policy formulation and planning.

The scope and the objectives of foresight vary from case to case and foresight processes can be designed to accommodate the needs of the particular, national, regional, supranational, industry sector or corporate case.

The term foresight is used in the sense of ‘outlook’. Technology foresight describes certain large outlook efforts to assist science and technology planning mostly on national level. Grupp and Linstone (1999), however, point out that the term technology foresight is used even if some topics touch on scientific exploration. The ‘classical’ and probably most cited definition of technology foresight is the one stated by Martin:

> Technology foresight is the process involved in systematically attempting to look into the longer-term future of science, technology, the economy, the environment and society with the aim of identifying the emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic and social benefits (Martin, 1995).

While Martin’s definition points out social and economic benefit, an earlier definition of Coates lays emphasis on learning and understanding and establishes the link to policy: Coates defines foresight as:

> …a process by which one comes to a fuller understanding of the forces shaping the long term future which should be taken into account in policy formulation, planning and decision making (Coates, 1985).

An increasing interest in technology foresight during the 1990’s, which in W. Preissl’s wording is already a ‘fashion’ (Preissl, 2001) is acknowledged by all authors. It is therefore important to understand the economic and political background that has led to this increased interest; in other words why policy, academia, and business are in need of foresight.

The main drivers of change in the global economy and hence the drivers of technology foresight are nowhere better expressed than in Martin in terms of the 4C’s. These are examined below:

C1 – Increasing **C**ompetition: Globalization has led to increased economic competition between countries as well as firms in an increasingly competitive world where innovation and knowledge based industry and services dominate. In this world, new technologies and the underpinning scientific research have become key elements of economic and social development. The research in emerging technologies is too expensive and cannot be carried solely by the private sector. Government support is necessary, but, governments cannot afford to fund all areas of research and technology simultaneously; they have to be selective. Furthermore, new national science and technology policies need to take into account social factors such as unemployment and working conditions, inequality and social cohesion, environment and sustainability, and new risks directly associated with the introduction of new technologies. Technology foresight thus offers a tool that helps governments to decide, which technologies to support and to devise policies that can link science and technology more closely to the nation's economic and social needs (Martin and Johnston, 1999; Martin, 2001; Johnston, 2001).

C2 – Increasing **C**onstraints on public expenditure: While the cost of funding research in science and technology is rising, the set of constraints on government spending is also increasing. Governments in many countries have to deal with growing demands in respect to functions such as health, welfare and education, while particularly tax revenues are decreasing as a result of political and economic pressures. The constraints on public spending call for justification or greater accountability of government funding of research and technology. The rising cost of scientific research and technological development requires governments to make choices for clear research and technology priorities and incorporate these into explicit policies. In other words, a new social contract is needed for researchers, funding organizations and users. Previously, funding priorities were selected tacitly, - they 'emerged' from the policy process. The requirements for priority setting, justification and accountability have drawn attention to technology foresight. Technology foresight offers itself as a policy tool that can help governments to identify research and technology priorities while also serving to the justification of public funding and accountability of governments (Martin and Johnston, 1999; Martin, 2001; Johnston, 2001).

C3 – Increasing **C**omplexity: Another driver of the global economy and foresight is identified as a trend towards growing complexity. The global economy is driven by the interactions of a variety of different systems of local, national, regional and global nature. Research and technology, the economy, politics, culture, environment, the public and private sectors are factors contributing to the growing complexity of interactions. In addition, the nature of knowledge production is shifting towards transdisciplinarity and heterogeneity. The range of knowledge producers is expanding and there is considerable 'blurring' of the institutional boundaries between them, for instance, between the industrial and university sectors (Gibbons et al., 1994). Hence, there is need for increased communication, collaboration, partnerships and networks among researchers as well as between researchers and users in industry. Technology foresight facilitates a process for understanding complex systems and addressing the resulting issues in a systematic, open and collaborative manner (Martin and Johnston, 1999; Martin, 2001; Johnston, 2001).

C4 – Increasing importance of scientific and technological **C**ompetencies: Scientific and technological knowledge is vital to wealth creation and improvement of life quality and is thus becoming a strategic resource for companies as well as countries. When speaking of competencies we need to distinguish between knowledge and skills. There is also an important distinction between 'codified knowledge' that is written in textbooks, scientific papers, patents etc. and 'tacit knowledge' that is poorly articulated in words but expressed in all sorts of practice (European Foundation for the Improvement of Living and Working Conditions, 2003) and is best transferred through the face to face interaction of people and organizations.

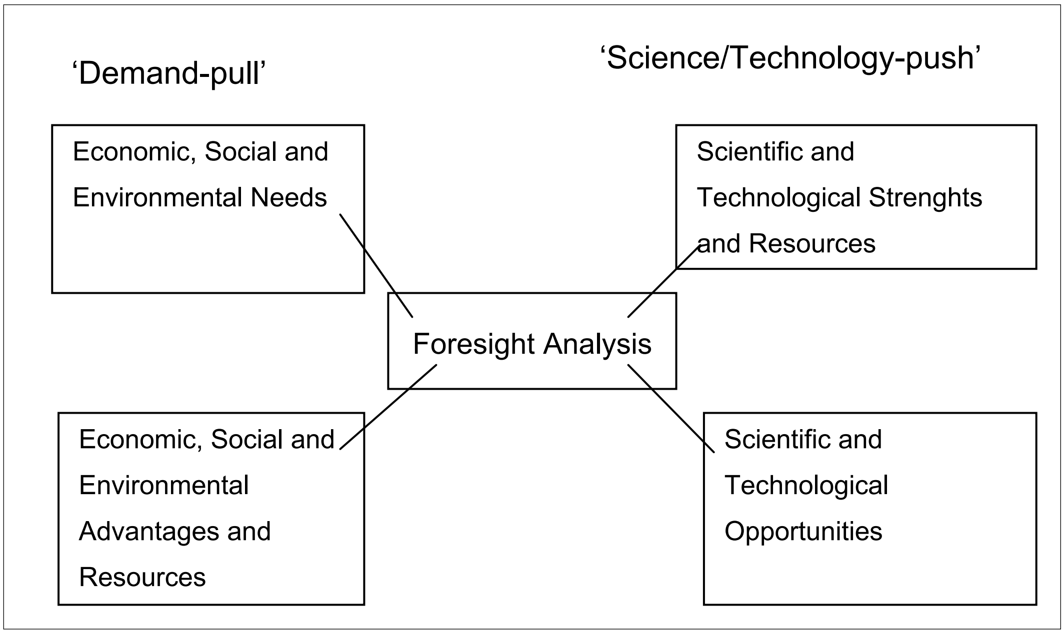
New technologies not only demand new skills, but also make old skills obsolete; therefore, continuous learning for individuals and companies becomes essential. While at the individual level this represents the need for 'lifelong learning', at the organizational level, the creation of the 'learning organization' is at stake. Furthermore, the growing complexity and interaction of systems calls for new generic or system wide skills such as interdisciplinary approaches, team-working, networking and collaborating.

Technology foresight offers a process that promotes the exchange of tacit knowledge and fosters continuous learning and the development of generic skills (Martin and Johnston, 1999; Martin, 2001; Johnston, 2001).

It is because of this background that technology foresight came to prominence. According to a famous model by Georghiou (2001), the rationale and practice of foresight has evolved through three generations. First generation foresight was in the realm of technological forecasting and aimed at revealing the future course of S&T. The actors of the first generation involved experts in various fields of technology and professional futurists. The second generation foresight, as exercised in the 1990’s by many countries, takes a market and industry perspective for determining future S&T capabilities demanded by social and economic sectors. The actors of second generation foresight include representatives of business circles, academia and the public sector. Starting with the 2000’s a new wave of foresight that is organized by thematic issues (for instance the ‘ageing society’ or ‘crime prevention’) and concentrated on solving socio-economic problems appeared. This is characterized as third generation foresight and retains the actors from the second but also attempts to engage groups representing citizens and non-governmental organizations with particular objectives (Georghiou, 2001).

Another important aspect of foresight is that it offers a balanced approach to the 'science and technology-push' and 'demand-pull' factors that influence future developments and the evolution of technology. Science-push factors account for the creation of new technological or commercial opportunities by scientific research, and the competency and available resources to exploit them. Conversely, developments in technology and production can create a use for existing and new scientific developments through the mechanism of demand-pull. The priorities and needs of the public are also reflected in the demand factors.

Technology foresight is a process of looking ahead and generates communication and interaction between scientists and technologists, representing 'science push', and social scientists, industrialists, businessmen, other professionals and the citizens representing 'demand-pull' to produce a balanced perspective that may be deemed as valuable by planners and policy makers (Tegart, 2003).



Source: Tegart (2003)

Figure 2.3: Factors Influencing Foresight

2.4.1 Technology Foresight as a Policy Tool

Nyiri (2003), refers to the fields of knowledge we have covered so far as policy formulation tools and outlines their features as given in below Table 2.2. Although other authors may disagree to Nyiri's distribution of features (for example to whether forecasting or future studies is action oriented or not), the table is considered helpful in pointing out the most important aspects of each policy formulation tool.

Table 2.2: Policy Formulation Tools

	Foresight	Forecasting	Assessment	Future Studies	Strategic Planning	Policy Analysis
Interactive	●					
Large Participation	●					
Bottom Up	●					
Future Intelligence	●	●		●	●	
Long term	●	●		●	●	
Socio-economic impacts	●	?	●		●	●
Analysis	●	●	●	●	●	●
Action oriented	●				●	
Mobilizing joint actions	●					
Technology identification	?	●				

Source: Nyiri (2003)

Whether foresight leads to 'technology identification' is left as a question mark in Nyiri's table, in order to point out that foresight can not only be done in the context of science and technology policy but in relation to other topics, such as health, the environment etc. However, in Martin's definition of technology foresight given above, this feature is emphasized as its explicit purpose.

The highlighted features in Table 2.2 are those that are unique to foresight. As the table suggests, foresight, in contrast to other policy formulation tools involves a bottom-up interactive process with large participation and aims to mobilize joint actions. Similarly, the EU's, Martin's and Coates' definitions all emphasize the 'process' aspect or procedural power of foresight which is referred to by Martin and generally in foresight literature, similar to the 4C's or drivers of foresight, as the 5C's of foresight. The 'process benefits' or the 5C's of foresight are:

Communication – Foresight brings together researchers, funding orgnizations, policymakers and users that are concerned with the future of science, technology and innovation and facilitates communication among them.

Concentration on the longer term – The average time horizon for national and regional foresight exercises is around 10-15 years, although it can be longer than 30 or as short as 5 years. Foresight forces participants to concentrate on such longer terms, without which short-term problems tend to dominate.

Coordination – Foresight facilitates coordination among researchers and between researchers and users.

Consensus – Foresight helps participants to develop consensus on desirable futures.

Commitment – Foresight builds up the commitment to convert emerging ideas into action (Martin, 1995; Johnston, 2001).

These process benefits are those features that substantially distinguish foresight from the other policy formulation tools. They emphasize that process is as important as outcome or results. The success of a foresight exercise can be measured by assessing it against the 5C's. In fact, the emphasis on the process is in line with the changing nature of science and technology policy in societies. Such change is reflected in the 'systems of innovation' approaches and the notion of the 'national innovation system' which were introduced and entered the vocabulary of policy makers in the last two decades (Edquist, 1997, p. 3; Lundvall, 1992, p. 5). Edquist (1997) defines innovations as "new creations of economic significance" which, "may be brand new but are more often new combinations of existing elements".

There are various kinds of innovations (such as technological or organizational etc.) but the central focus is often on technological innovation. Innovation processes occur over time and are influenced by many factors. They do not occur in isolation but through the interaction of people and organizations and the exchange of knowledge. In order to understand and explain innovation processes, we need to understand the relationships and linkages between organizations (firms, universities, research organizations, financing organizations, government etc.) as well as the institutions that constitute constraints and incentives for innovation (laws, cultural norms, social rules, technical standards etc.). The ‘systems of innovation’ approach offers a way to understand and influence processes of innovation (Edquist, 1997, p. 2). According to Lundvall a ‘national system of innovation’ can be defined as: “the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and are either located within or rooted inside the borders of a nation state.” (Lundvall, 1992, p. 2). A national innovation system in a broad sense includes:

> …all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring- the production system, the marketing system and the system of finance … as subsystems in which learning takes place (Lundvall, 1992, p.12).

Here, the focus on the national level does not contradict with the widely recognized trends towards globalization or even regionalization. Since processes of innovation are to a large extend characterized by interactive learning, and interactive learning and innovation will be easier to develop in the same national environment sharing norms and culturally based forms of interaction, national systems still play an important role in supporting and directing the complex and collaborative process of innovation (Lundvall, 1992, p. 3).

The national innovation system concept has far reaching implications and offers new rationales and new approaches in the context of science and technology policymaking (OECD, 1997, p. 41). Metcalfe argues that,

> The principal aim of technology and science policy from a systems perspective is to ensure the creation of effective knowledge support systems, which bridge between industry and the science and technology base. By contrast, the principal aim of innovation policy must be to combine the scientific and technological knowledge with knowledge of market opportunities and organizational opportunities (Metcalfe, 2002).

According to the Organisation for Economic Co-operation and Development (OECD), the new rationale for government funding of research and technology is based on correcting ‘systemic failures’ - in other words, the lack of effective interactions between the actors in the system. Therefore, new policies should address these systemic failures and promote networking, cooperation and the linkages between the component organizations that make up the national innovation system. In this context, joint research activities and other technical collaboration among enterprises and with public sector institutions; schemes to promote research and advanced technology partnerships with government are regarded as valuable (OECD, 1997).

There are two aspects when speaking of technology foresight as a ‘policy tool’. The first aspect is that technology foresight can be used as a tool to assist policy formulation. The second is that technology foresight may itself serve as an instrument in the context of policy implementation. According to Metcalfe,

> The process involved in conducting a large-scale foresight program is precisely a matter of bridging and connectivity within a nation’s science and technology base and between that base and its areas of application (Metcalfe, 2002).

Martin and Johnston (1999) argue that technology foresight offers a fruitful mechanism for pursuing innovation policy. It is

> …a means of ‘wiring up’ and strengthening the connections within the national innovation system, so that knowledge can flow more freely among the constituent actors and the system as a whole can become more effective at learning and innovating (Martin and Johnston, 1999).

As examined above, the process benefits or 5C’s of foresight reflect the importance of encouraging productive long-term partnerships among researchers and among firms, across industrial sectors, and between industry, universities, government, and society at large.

In conclusion, “innovation systems, like all institutions are not natural givens, they have to be constructed and they develop over time in response to incentives and opportunities” (Metcalfe, 2002). Strengthening the national innovation system means to stimulate, extend, and deepen the interactions of the various actors so that they learn and innovate more effectively. Technology foresight offers a mechanism to help achieve this and thus serves as a tool for wiring up the national innovation system (Martin and Johnston, 1999).

2.4.2 Foresight Methodology

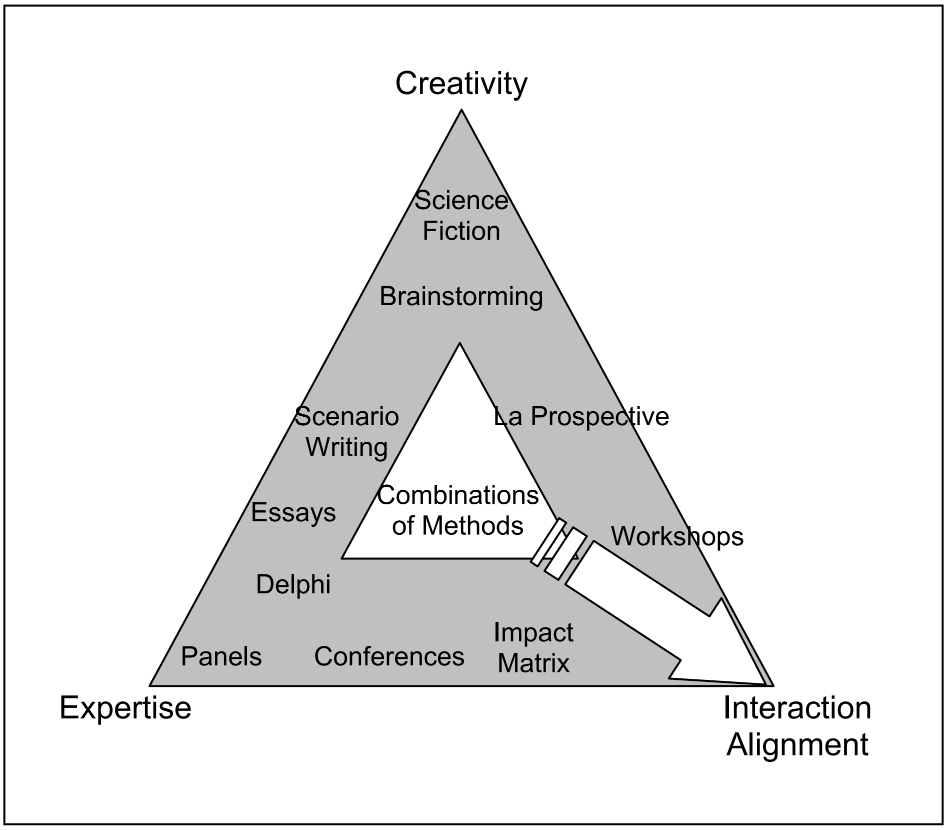
In general, the need for formal methods in foresight arises out of the tasks of constructing hypotheses about possible futures; inquiring with experts and ensuring their involvement in the overall process, and selecting priorities (Gavigan and Scapolo, 1999). However, a valid general statement about foresight methodology would be that a unique set of methods for all foresight exercises does not exist. The choice and combination of the range of methods depends on each individual case and the scope and objectives of the foresight exercise in question. In fact, Johnston suggests that “the development and refinement of the range of foresight techniques with a clear appreciation of their appropriate area of application” is one of the “particular areas of challenge” in foresight (Johnston, 2001). Overall, there are actually such attempts and the literature includes various compilations and classifications of foresight techniques. The Battelle report (1997) for instance establishes six major categories of ‘foresighting methods’- ‘expert opinion and scenario building’ which emphasize human participation, ‘modeling and morphological analysis’ which depend on the use of computer models and ‘scanning/monitoring and trend extrapolation’ which predict the future on the basis of past data. Yet, it is noted that the boundaries between the categories are not necessarily firm, and that methods can merge from one category into the next (Battelle Seattle Research Center, 1997). A more recent study by the ‘technology futures analysis methods working group’ comprising of nineteen reputable authors attempts to integrate the methods for analyzing future technology, including foresight, to fit into the umbrella concept ‘technology futures analysis’. The group of authors has compiled a table of the many methods ‘technology futures analysis’ may utilize. The methods are categorized into nine families defined as ‘creativity’ (e.g. brainstorming), ‘descriptive and matrices’ (e.g. roadmapping), ‘statistical’ (e.g. correlation analysis), ‘expert opinion’ (e.g. Delphi), ‘monitoring and intelligence’ (e.g.

environmental scanning), ‘modeling and simulation’ (e.g. cross-impact analysis), ‘scenarios’ (e.g. scenario management), ‘trend analysis’ (e.g. trend extrapolation) and ‘valuing/decision/economic’ (e.g. decision analysis, relevance trees). Furthermore, each method is labeled as hard (quantitive), soft (qualitative) and exploratory or normative (Technology Futures Analysis Methods Working Group, 2004). The distinctions of exploratory versus normative methods and quantitative versus qualitative methods are also well established in the literature. Exploratory methods are ‘outward bound’; they begin with the past and present as the starting point and move forward to the future in a heuristic manner, often looking at all available possibilities (Gavigan and Scapolo, 1999). The majority of forecasting studies are of exploratory nature. Trend, impact, and cross-impact analyses, conventional Delphi, and some applications of models can be labeled as exploratory methods (FOREN, 2001, p. 27). Normative methods on the other hand are inward bound; starting with the future by determining future goals and objectives, then working backwards to determine if these are viable under the given constraints and with the available resources and technologies (Gavigan and Scapolo, 1999). Various techniques developed in planning and related activities, such as relevance trees and morphological analyses, together with some uses of models and some less conventional uses of Delphi such as “goals Delphi” methods can be labeled as normative methods. Normative approaches are most likely to be effective when a widely shared goal already exists. Foresight can then help to shape and elaborate the vision of the future. In the early stages of the foresight process and when there is a lack of consensus on shared goals, exploratory methods are expected to dominate (FOREN, 2001, p. 26).

Quantitative methods can be divided into time-series and causal techniques. In order that quantitative methods can be applied, information about the past must be available in the form of numerical data; and, there must be reasonable evidence that some of the aspects of the past pattern will continue into the future (Gavigan and Scapolo, 1999). Qualitative methods on the other hand are often employed where it is difficult to capture the key trends or developments via quantified indicators, or where such data are not available. They include different forms of creative or intuitive thinking, such as brainstorming, utopian writing and science fiction. In Social science the development of qualitative techniques lagged behind that of quantitative ones for a long time. It was expected that experts interpret the result of qualitative analysis and arrive at a synthesis through intuition. The situation has changed in the last decade and even computer-based tools for capturing, analyzing, processing and representing qualitative data have become available. For instance, mind-mapping and conversational analysis has been employed in some Foresight studies (FOREN, 2001, p. 27).

A prominent model of foresight suggests that foresight has three integrating themes. These themes are ‘expertise’, ‘creativity’ and ‘interaction - alignment’. In foresight, the three themes are not in opposition but all work through creative tension and may be depicted as lying at the vertices of a triangle (Figure 2.4). Interaction - alignment describes foresight’s capacity as a policy tool for interpreting the outcome of the tension between ‘expertise’ and ‘creativity’ into the policy making process (Cameron et al., 1996). Methods used in foresight may be situated within the foresight triangle, according to the appropriate distance to the vertices. For instance, while ‘expert panels’ are placed adjacent to the ‘expertise’ apex, ‘scenario writing’ appears at equal distance to the ‘creativity’ and ‘expertise’ apexes. The center of the triangle is left open to indicate that any combination of methods can be used during the foresight process and for the presentation of the outcomes. The process itself and the presentation of the outcome must achieve alignment with the needs of all stakeholders so that foresight gains the credibility to be used as an input in the policy making process (Cameron et al., 1996).

It needs to be noted here that none of the methods mentioned so far, were specifically developed for foresight but stem from futures studies or planning. Some of the methods such as ‘expert panels’ are not methods per se but play a supportive role. Expert panels, for instance, may be put together for formulating the questions in the Delphi survey method.



Source: Cameron et al. (1996 p.16)

Figure 2.4: The Foresight Triangle and Foresight Methods

Another compilation of foresight methodology according to three criteria is shown in Table 2.3. The first group of methods is based on eliciting expert knowledge. This group of methods is widely used in national foresight exercises. As a matter of fact, the nature and organization of a foresight exercise very much depends on the choices made concerning the eliciting of expert knowledge or ‘breadth of consultation’. Here, Cameron et al. (1996) distinguish between broad and narrow consultation. Narrow consultation is characterized by the ‘expert committees’ that rely entirely on their own resources and do not consult outside themselves. Broad consultation on the other hand involves survey methods conducted by a central management group (Cameron et al., 1996, p. 18). It is of course possible to employ a mix of both approaches, as was done in the Turkish technology foresight study.

Table 2.3: Classification of Foresight Methods

CRITERIA	METHODS
1. Methods that are based on eliciting expert knowledge to develop long-term strategies.	- Delphi method - Expert panels - Brainstorming - Mindmapping - Scenario analysis workshops - SWOT analysis
2. Quantitative methods that make use of statistics and other data.	- Trend extrapolation - Simulation modeling - Cross impact analysis - System dynamics
3. Methods to identify key points of action to determine planning strategies.	- Critical / key technologies - Relevance trees - Morphological analysis

Source: FOREN (2001, p. 100)

The second group involves quantitative methods that make use of statistics and other data that are used more in the realm of forecasting rather than foresight. Nevertheless, they are important to predict technological developments and may be taken into account in the context of foresight processes. Quantitative methods may also be useful in presenting foresight results. The third group of methods deals with identifying key points of action to determine planning strategies. Planning methods have been extensively developed and reached high levels of sophistication in the last few decades. Their suitability to foresight is limited since they usually focus on shorter terms and deal with circumstances of lesser unpredictability than foresight does (FOREN, 2001, p. 116).

Below, we will focus on two foresight methods that bear relevance in respect to the Turkish Case. The first is the Delphi method or survey technique which is often associated with national foresight exercises as their most common and preferred technique. The second is scenario analysis which we will briefly describe since it is a very important technique for visualizing the future. Scenario analysis was not incorporated in the Turkish case, although initially planned. The descriptions of the other methods can be found in the FOREN Guide (FOREN, 2001) and also in the extensive range of literature available on foresight methodology.

2.4.2.1 The Delphi Method

The Delphi method was developed in the 1950's by the RAND Corporation and is, inspired by its significant use in forecasting, named after the Greek oracle of Delphi (Murray, 1979). The pioneering contributions in the development of the method came from RAND researchers Kaplan et al. (1950), Helmer and Rescher (1959), and Dalkey (1969).

Linstone and Turoff (1975) characterize Delphi as "a method for structuring a group communication process, so that the process is effective in allowing a group of individuals as a whole, to deal with a complex problem". In essence, this comes down to an iterative survey conducted anonymously with people believed to be experts in the areas being studied. A Delphi survey is conducted in at least two rounds by using questionnaires. After each round, the results are disclosed to the respondents who then have the option to either stay with their original assessment or change it in the next round. The number of Delphi rounds is variable and it is important to continue until there is stability (Grupp and Linstone, 1999). In practice tough, the number of rounds seldom goes beyond one or two iterations in which stability of participants' opinion is already reached and due to dropping interest. (Rowe and Wright, 1999; Grupp and Linstone, 1999).

The major difference of Delphi to other opinion surveys is the feedback provided to the respondents on the outcome. In this way, respondents learn from the opinions of the other participants and consensus is sought. A Delphi survey is hence a controlled debate where the goal is to achieve a convergence of opinions (FOREN, 2001). The underlying assumption is that predictions made by a group are more likely to be correct than predictions made by the same individuals alone (Murray, 1979).

RAND Researcher, Dalkey (1969) expresses the three basic features of Delphi procedures as: 'anonymity, 'controlled feedback' and 'statistical group response' whereby the latter describes that the group opinion is defined as an appropriate aggregate of individual opinions in the final round. At the same time, these features ensure that biasing effects of dominant individuals, irrelevant communications and group pressure towards conformity are suppressed (Dalkey (1969). Considering the cultural dimension, Johnston (2001) argues that the 'anonymity' feature of Delphi is particularly valued in societies and organizations that are strongly hierarchical.

When assessing the long range of 20 to 30 years ahead, the only source of information available is expert opinions. The Delphi method is based on gathering subjective opinions based on informed judgment and intuition. Therefore, it is suitable for assessing long term issues with high levels of uncertainty and offers itself as a useful method for foresight processes. Since the 1950s, the use of Delphi has spread from its origins in military research in the U.S.A. to a variety of areas in numerous countries. Starting from 1969, the Japanese took the lead in the development and application of the Delphi method as part of their foresight activities and have been conducting Delphi surveys every five years since. In the new wave of government foresight in the 1990's, European countries such as Germany, France, United Kingdom, and many others followed the Japanese example to employ Delphi in their large scale foresight exercises (Grupp and Linstone, 1999).

The practice of organizing a nation-wide Delphi survey is a resource-intensive, time-consuming and complicated process which needs to be guided by a steering committee and/or management group. Delphi questionnaires such as those used in a national technology foresight exercise comprise of specific statements that are listed under chosen sectoral or thematic fields and topics. These statements are usually formulated by expert panels set up under the steering committee in accordance with the chosen fields. Delphi participants, also experts of different levels are asked to assess these statements according to certain criteria such as ‘importance’ and ‘estimated time of realization’. It is also customary to ask the participants about their level of expertise on the topic or statement in question. This self-rating provides valuable indication about the significance of the responses later-on. This is not in the sense that only the responses of top level experts are considered as valuable. On the contrary, the question whether the response of top-experts is more reliable is highly debated. For instance, it has been observed that there is a tendency to overrate a field in which a person is engaged; in other words, that there is a certain insider-bias. It was shown that the assessment of self-rated top experts tends to suffer from over-optimism. Delphi studies, assume that it pays to base assessments on different levels of expertise and “make full use not only of the answers from top experts but also of experts from the upper half range at least” (Tichy, 2004).

The Delphi method has been subject to waves of criticism in academic circles in the 1970’s and 1980’s. This criticism was directed towards methodological weaknesses as well as deficiency in execution (Tapio, 2002). One fundamental critique was that the Delphi procedure may lead to ignorance of deviating responses and produce a false consensus (Murray, 1979; Tapio, 2002). Delphi variants like the policy Delphi, which “seeks to generate the strongest possible opposing views on the potential resolutions of a major policy issue” (Linstone and Turoff, 1975) have been developed to address this problem. On the other hand, poor formulation of the Delphi statements or ambiguous questionnaires, poor or biased selection of experts, scarce feedback and summary reports are listed under deficiencies of execution.

The Delphi process yields a variety of statistical data, which may be analyzed, interpreted and presented in many ways (UNIDO, 2003). (Details and examples will be provided in Chapter IV- The Turkish Case). However, Pill (1971) points out that there is really no generally acceptable means of gauging the validity and accuracy of the output of a procedure like Delphi. Consequently, one must not forget that "the output is still at best, an opinion and must be treated as such" (Pill, 1971). It follows that the use of a Delphi survey should be judged in terms of its usefulness to a decision-maker rather than in terms of its accuracy (Murray, 1979).

2.4.2.2 Scenario Analysis

In the common language, the term 'scenario' is understood to describe the script for a film or play. Upon listing different dictionary definitions of 'scenario', Coates (2000), finds that the definition - "An imagined sequence of events, esp. any of several detailed plans or possibilities"- is the closest to what futurists do.

'Scenario analysis' or 'scenario planning' is about organizing information and future possibilities into alternative visions for the future, with the aim of drawing consequences for the possible actions of today. Scenarios consist of visions of future states and courses of development, organized in a systematic way as texts, charts, etc. Scenarios may be composed of a combination of quantifiable and non-quantifiable components that are arranged as logical sequences of events (FOREN, 2001).

Coates (2000) leads back the origins of 'scenarios' as an organizational or institutional device for clarifying thinking about the future to the Department of Defense in the 1950s and mentions the pioneering role of Herman Kahn. In Kahn's 'escalation ladder', which Coates (2000) describes as a monumental contribution, variations or stages of what may occur between 'nuclear war' and 'no war' under different circumstances were described. Coates (2000) finds that "the great value of a scenario is being able to take complex elements and weave them into a story which is coherent, systematic, comprehensive, and plausible".

There are various types of scenario approaches and methods of scenario building. Coates (2000) distinguishes two broad categories of scenarios. The first category of scenarios describes some future state or condition in which the organization is embedded and stimulates the development and clarification of practical choices, policies, and alternative actions that may be taken to deal with the consequences. The second category of scenarios assumes that policy has already been established and integrates its consequences into a story about some future state. Scenarios in this second category thus help to display the consequences of a particular choice or set of choices (Coates, 2000).

Barbieri Masini and Vasquez (2000) identify two different approaches in scenario building. The first approach is characterized by its emphasis on intuitive logic and pragmatism. Here, the writing of scenarios is a form of literary practice, an art, drawing on the knowledge and creativity of the participants to determine alternatives and seeking to stimulate debate on the future. This approach was developed by Ian Wilson and the Stanford Research Institute (SRI) and successfully applied by the Shell Oil Company. Another example of this approach is given in Peter Schwartz's book, 'The Art of the Long View'.

According to Schwartz (1996), "Scenarios are a tool for helping us to take a long view in a world of great uncertainty".

> In a scenario process, managers invent and then consider, in depth, several varied stories of equally plausible futures. The stories are carefully researched, full of relevant detail, oriented toward real-life decisions, and designed … to bring forward surprises and unexpected leaps of understanding. … The point is to make strategic decisions that will be sound for all plausible futures (Schwartz, 1996, pp. xiii-xiv).

As the quote suggests, the SRI-Shell Method, does not dwell on the probabilities of specific events occurring, but is oriented towards specific decisions.

The second approach, influenced by the calculation of probabilities and operational research, relies on mathematical methods for scenario building. This approach, created by Godet (1994) and referred to as 'strategic prospective', identifies a process that brings together different techniques such as cross impact analysis and structural analysis etc. (Barbieri Masini and Vasquez, 2000). It is more complex and devotes a lot of effort to the identification of probable futures. Barbieri Masini and Vasquez (2000) suggest a third approach – the scenario method according to human and social future studies, which has common points with both approaches described so far, but lays emphasis on 'flexibility'. The scenarios are conceived as a process that does not close but can be adapted in response to changes of actors or situations.

Scenarios are used as a tool in businesses, in various kinds of organizations and in government planning. Within foresight programs, the term 'scenario' is used to cover a wide range of different activities. Scenarios are used as inputs to start discussions and idea generation in panels, as tools for testing the robustness of policies or as means for the presentation of foresight results to the wider public (UNIDO, 2003). In foresight programs, scenarios are often developed in workshops or by smaller expert groups by a systematic evaluation of trends, drivers, and alternatives. But, being a well-known method in futures studies, scenario analysis has been less prominent in foresight. This appears to be changing as more foresight programs incorporate scenario methodology. The second round of UK foresight program for instance, invested substantial resources into developing a set of alternative future scenarios. Reconciling the workshop-based development of scenarios with their wider use in a foresight process in which numerous panels and issue groups are active, is seen as an interesting challenge (UNIDO, 2005a). In Chapter III, the Hungarian foresight study, in which scenarios have been used, is examined.

2.5 Concluding Remarks

Foresight has emerged as a new policy tool and came to widespread use in the 1990's. It draws on the knowledge and methodology base used in the related fields of 'future studies', 'policy analysis' and 'strategic planning'. In conjunction with these fields, the terms 'policy', 'strategy' and 'plan' have different meanings and it is important to distinguish these. It is also important to distinguish foresight from policy, as foresight results are not automatically converted to policy. Foresight results may serve as input to the policy processes, decision making and strategy development.

The philosophical starting-point of foresight is the assumption that the future is not predetermined nor an extension of the past, but, can be actively shaped by today's actions. Foresight can be conducted on national, regional, supranational, industry sector or corporate level and the scope and the objectives of foresight vary from case to case. Technology foresight describes certain large outlook efforts to identify promising fields of technology and assist science and technology planning mostly on national level. It offers a balanced approach between science and technology push and demand pull factors that drive technological progress. Foresight processes are evolving over time, in terms of rationale, objectives and actors involved, so that now it is possible to identify three generations of foresight activity.

A particular significance of foresight is that it involves a bottom-up interactive process with large participation and aims to mobilize joint actions. Hence, as a policy tool its process benefits in bringing together various actors in the national innovation system are considered as important as its outcomes in terms of technology lists and policy advice. It can therefore be considered as a tool for wiring up the national system of innovation.

In Chapter II we have covered the theoretical issues for understanding technology foresight. In Chapter III some case studies of foresight in action are examined. The intention is thus to provide the background information for understanding the Turkish technology foresight study, Vizyon 2023, as described in Chapter IV.

CHAPTER III

INTERNATIONAL EVIDENCE ON FORESIGHT IN ACTION

Technology foresight has gathered momentum early in the 1990's and especially became a widely used policy tool in the European countries. Japan had already embarked on technology foresight in the 1970's and has since been conducting a regular Delphi survey approximately every 5 years. The results of the 8th Science and Technology Foresight Survey of Japan targeting the year 2035 have been recently published (NISTEP, 2006). The United States has taken a different approach than the foresight exercises in Japan or Europe and has sponsored a 'critical technologies identification' effort between 1989 and 1999 (Wagner, 2003). In the United Kingdom (UK) three rounds of foresight have been implemented so far, with the last round still continuing. The UK example is in particular representative of how a country develops experience with the foresight approach over time. As a matter of fact, there are as many different approaches to foresight as there are applied studies.

Table 3.1 provides a list of different countries' foresight programs showing the responsible organization that was in charge of the foresight program, the objectives of the foresight, the time horizon and the major methodologies employed. It should be noted however that such compilations are only to provide a rough overview and can not be expected to capture the objectives or the significance of the foresight studies correctly. It should also be noted that technology foresight exercises produce a vast amount of documentation which is most difficult to sort out in order to gain a clear overview, unless insider information is accessible, let alone the fact that these documents are often only available in the language of the country in question. This may be one reason that the UK foresight program is most often referred to and taken as example by many countries.

Table 3.1: Technology Foresight Programs in the World

Country	Responsible Organization	Objectives		Time Horizon	Methodologies
Australia	Australia Science and Technology Council (ASTEC)	Establish framework for S&T policy, Consensus building	Communication/ Education	15 years	Scenario Analysis/ Delphi/ Relevance tree / morphological analysis
Austria	Ministry of Science and Transport Innovation and Technology Funds (ITF)	Identify niches of competitive position, Identify strengths and weaknesses of technological sectors	Technology Policy recommendations	15 years	Technological Delphi and Social Delphi
France	Ministry of Industry Ministry of Superior Education (MES)	Determine priorities of Industry and Society , Anticipatory Intelligence	Policies recommendations, Consensus building	5 to 10 years 30 years	Lists of critical technologies (1993) Delphi (1993)
Germany	Federal Ministry of Education, Science, Investigation and Technology Fraunhofer Institute for Innovation Research	Policies recommendations in S&T, Anticipatory Intelligence	Consensus building Determine priorities (2nd Delphi)	10 years 30 years 30 years	Lists of critical technologies/Relevance trees (1991) 1st Delphi (1992) Mini-delphi (1994) 2nd Delphi (1996)
Holland	Ministry of Education, Culture and Sciences	Determine Research Priorities, Anticipatory Intelligence	Consensus building Communication/ Education	10-15 years 25 years	List of emerging/critical technologies (1989-94) Scenario Analysis (1990)
Hungary	Ministry of Science and Technology National Commission for Technological Development (OMFB)	Identify strengths and weaknesses of S&T system, Explore potential opportunities in the EU	National innovation strategy, Increase private sector productivity	15 years	Delphi Scenarios
Ireland	Irish Council for Science and Technology	Identify future opportunities for the country		Not indicated	Scenarios with Expert Panels/ Consults
Italy	Fondazione Rosselli	Support decision making processes and strategies development for the long run		Not indicated	Emerging/ critical technologies
Japan	Japanese Science and Technology Agency (STA)	Long run technological development , S&T policy recommendations	Future society vision	30 / 20 years/ 10-15 years	6 Delphis/ Expert panels/ Scenarios/ technologies mapping

Table 3.1 (continued): Technology Foresight Programs in the World

Country	Responsible Organization	Objectives		Time Horizon	Methodologies
Korea	Ministry of Science and Technology	Increase competitiveness of local industries, Determine priorities	Long run planning of R&D in Critical technologies.	10 years 5 years 20 years	Emerging/Critical technologies Expert panels (1992) Delphi (1992)
New Zealand	Ministry of Research, Science and Technology	Determine national priorities	Identify challenges in becoming a knowledge society	15 years	Expert panels Quantitative analysis
Spain	Ministry of Industry	Technology policies recommendations, Industrial competitiveness, Development of new industrial capacities and technologies	Knowledge information base on impact on new technologies in Industry, Employment and Competitiveness	15 years	Delphi
Sweden	Royal Swedish Academy of Engineering Sciences (IVA), Swedish National Board for Industrial and Technical Development (NUTEK), Swedish Foundation for Strategic Research, Federation of Swedish industries	Promote long-term interplay between technical, economic and social processes, Strengthen future-oriented approach in companies and organizations	Compile information and design processes for identifying high-priority areas in technological fields, Identity areas of expertise with potential of growth	10-20 years	Expert Panels
UK	Office of Science and Technology (OST) Policy research in Engineering, Science & Technology (PREST)	Determine priorities in C&T, Anticipatory Intelligence, Future Visions: possibilities and necessities	Communication/ Education, Link Science and Industry	10 to 20 years	Consults/Delphi /Panels of Experts Task forces/ "Knowledge Pool"
USA	Office of Science and Technology Policy (OSTP)	Determine Research priorities for National Security and Economic prosperity	Policy recommendations, Anticipatory Intelligence	10 to 15 years	Emerging/critical Technologies Panels

Source: UNIDO (2005b)

National technology foresight exercises are difficult to compare because of the methodological differences and the cultural context. Nevertheless, the literature includes such comparisons made in terms of methodology or objectives of the foresight exercise. Gavigan and Scapolo (1999) for instance have attempted such comparison, in which national exercises are compared by objectives such as whether they include vision-building, identification of priorities and follow up actions. Alsan and Oner (2004) have proposed an integrated foresight management model (IFM) to provide a checklist with an integrated and holistic approach about the impact of foresight, for the comparison of national foresight studies.

We have chosen to examine two distinct national foresight examples in more detail: The French and the Hungarian cases. These have been chosen to demonstrate the variety of approaches and methodology that exists in conducting national foresight exercises, and on the basis of the quality of the literature that was available. This choice does not indicate that these examples are representative of certain foresight approaches more than others; however, they are deemed significant in respect to their distance to the Turkish exercise. While the Hungarian foresight addressed broad socio-economic needs, the French foresight sought to identify priorities in a more narrowly defined S&T context. It will become evident in Chapter IV that the Turkish technology foresight lies somewhere in between these two approaches.

3.1 The French Technology Foresight Study

In France, the first extensive technology foresight study in 1993–1994 had been sponsored by the Ministry of Industry. This was a content-oriented foresight exercise and the resulting report ‘100 Key Technologies for French Industry in the year 2000’ was published in 1995. In 1998 - 1999 a second foresight study was launched. The Ministry of Industry issued a specification and conducted a tender which was rewarded to CM International to act as a consultant. The objective besides updating the previous report was also to attain methodological improvement. The expected methodological improvements were first, to better integrate the market perspective into the analysis to account for the demand side, second, to identify the interconnections among the technologies listed as key and third, to mobilize a larger number of experts in the whole process as compared to the small number of experts (around 100) who had contributed to the former exercise in order to generate the process effect (Durand, 2003). According to Durand (2003), the last requirement leads to a major challenge that is faced by many foresight studies, namely that of balancing the requirement for the stated outcome (key technology lists, strategy documents) against the process. Durand (2003) emphasizes that in the French case, the ministry had tried to focus the foresight exercise on the content by asking for a list of technologies while at the same time the involvement of as many experts as possible was mandated, so as to promote a wide debate and yield process benefits.

The French foresight study was roughly targeted to cover a time horizon of 5 years ahead. A steering committee of 42 members, representing various ministries, industry, public agencies, and public research centers was established to monitor the project. In the implementation of the foresight the following nine thematic sub-groups were established:

1) Life Sciences – Health – Food
2) Information and Communication Technologies
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
9) Interaction and Quality (Durand, 2003)

The ninth sub-group, ‘Interaction and Quality’, had been recommended as a result of a preliminary study on methodology, conducted prior to the exercise. This sub-group was dedicated to deal with interaction among the technologies proposed by the other eight sub-groups and to maintain a reasonable level of quality (Durand, 2003).

A total of about 650 experts selected through a co-nomination process participated in the French exercise. The number of experts that participated in the sub-groups was about 150 with about 12 experts per sub-group while the remaining 500 experts contributed by responding to the mail questionnaires and by using the Internet forum that had been established. The overall project implementation took about 15 months with about 70 half-day meetings organized (Durand, 2003).

The exercise started with the identification of 600 potentially important technology items. This list was reduced to 200 technology items by selection according to the following criteria of attractiveness which had been established by the steering committee and included both the French and the European perspective.

1) Industrial and economic stakes for the technology:
- Current and future market size,
- Opportunity to build/defend a competitive position,
- Potential of dissemination in firms,
- Potential for mass production and cost cutting.

2) Environment preservation:
- Sustainable development,
- Energy and natural resource conservation,
- Emission control and waste management,
- Potentially adverse effects of the technology on environment.

3) Societal needs:
- Health, food safety and hygiene,
- Ageing,
- Culture, Education, Training,
- Potentially adverse effects.

4) National and European security:
- Security, defense,
- Industrial independence.

5) Technology dynamics:
- Lifting technology bottleneck and/or lock-up,
- Combinatory potential with other technologies,
- Propensity of technology to be absorbed by firms,
- Research-enhancing technology,
- Other (Durand, 2003).

During the first selection process the candidate technologies were grouped by the sub-group experts into 3 categories as, A - selected, B - undecided and C - rejected. Usage of weighing factors was considered as a mechanistic approach and was therefore avoided. The remaining 200 technologies were examined against another set of criteria, accounting for the competitive position of French and European players (Durand, 2003). These were:

1) Scientific and technological position:

- Presence of a scientific competence base/R&D capabilities,
- Knowledge base and capabilities for related or competing technologies,
- Favorable institutional setting: education, technology transfer, technical assistance,
- Existence of active and productive networks, including within the EU framework RTD program,
- Other.

2) Industrial and market position:

- Industrial capability on the technology,
- Capability in related or competing technologies in EU firms,
- EU firms' competitive positions versus market leaders,
- Favorable institutional setting: norms and standards, regulations, 'lead-market' to trigger and test a sequence of applications for the technology,
- Existence of active and productive networks: alliances, clusters, etc.,
- Availability of resources to implement and leverage the technology (industrial and commercial investments),
- Other (Durand, 2003).

As a result of this second round, 120 key technologies were identified and described in the final report.

The French exercise stands out with its notion of 'key technologies'. In Chapter II we had described the 'science and technology-push' and 'demand-pull' factors that influence future developments and the evolution of technology. Thus, when looking for critical technologies it is possible to start either at the functional needs on the demand side or at the technological options on the supply side likely to cause the science and technology-push effect. As a matter of fact, upon examination of the results of other countries' foresight exercises in terms of critical or key technology lists, it was recognized that the majority of the items listed as such actually represented functional needs. Consequently, it was decided that in the French foresight exercise, functional needs and technological options can be treated as the two sides of the same coin. In order to clarify the definition, scope and content of each potential key technology item, a six column-grid was designed, which is given in Table 3.2.

Table 3.2: Qualification Grid of Technologies Selected in French Foresight Study

Industries (1)	**Example of Use (2)**	**Function fulfilled (3)**	**Technology (4)**	**Critical technology points (5)**	**Scientific domains (6)**
Pharmaceuticals Cosmetics	Drug administration	Controlled release of substance	Micro-encapsulation	Molecule cage	Molecular chemistry
Waste management	Confining pollutants	Controlled confinement			

Source: Durand (2003)

In this table, the first three columns (1) – (3) characterize the demand side while the last three columns (4) – (6) characterize the technology. In the example given, the underlined item in column (4) is the selected key item or the 'flag' while the items in the other columns describe the key item. In the French exercise, this table was filled by the experts of the thematic groups for each item identified as a candidate key technology, with the flags of each of these technologies allowed to be positioned only in columns (3), (4), and (5). In the resulting list of key technologies then, it was possible to view a 'key technology' as either an entire line in the matrix or the underlined heading or flag, given in one of the three centre columns (Durand, 2003).

This approach can be considered as methodologically strong and useful in that the connection of the demand side or functional need to the technology is made very clear. When examining the Turkish case in the next chapter, it will become evident that this is not always the case in foresight studies and that in the Turkish case such clarity is lacking as to the connection of ‘technological activity topics’ and ‘technology areas’ (or ‘underpinning technologies’).

As to the implementation of the French foresight’s outcomes: A different approach was taken than that of the implementation of the 1993-1994 study, which was used to reorganize public funding and support 50 key technologies. The results of the 1998-1999 study were used to orient regional economic development in France. The scientific and technological potential of each region in France was evaluated in terms of the key technologies identified in the foresight. This regional focus reflects the important role assigned to regional development in the overall economic growth in France. The change in focus also shows how technology foresight can be adapted to changing contexts (UNIDO, 2005b).

3.2 Foresight in Hungary

Hungary launched its first foresight program, TEP, in 1997 during a period when the country was undergoing fundamental economic and social changes in the transition towards a market economy. The program was initiated and launched by OMFB, the National Committee for Technological Development, the government body then responsible for devising and implementing R&D policy. Nevertheless, the Hungarian exercise can be labeled as ‘foresight’ rather than ‘technology foresight’ for it emphasized alternative visions, institutional development and regulatory issues alongside technological issues (Havas, 2003).

According to Havas (2003), the foresight program did not enjoy a strong political support, because it was led by a single agency, OMFB, the government body then responsible for devising and implementing R&D policy and unfavorable political conditions, such as forthcoming elections and the prospect of government change that existed at that time. Furthermore, the legacy of central planning mandated to employ a bottom-up rather than a top-down approach, in order to make the study more credible. Accordingly, a steering group of 20 leading industrialists, academics and government officials, with the majority deliberately comprised of industrialists and academics with close contacts to businesses, was established to guide the program (UNIDO, 2005b; Havas, 2003). A program office was formed to coordinate the foresight and to provide methodological, organizational and logistics support for the steering group and the panels. A third body that was formed during the course of TEP was an Inter-ministerial Committee, composed of representatives of ministries and government offices, in order to coordinate and discuss the preliminary results of TEP and to provide information on continuing strategic projects for the panels and the steering group (Havas, 2003).

The objectives of the program were initially defined as:

- to devise viable research and development (R&D) strategies and identify technological priorities,
- to strengthen the formal and informal relationships among researchers, business people and civil servants,
- to support the preparation for the accession negotiations with the European Union (Havas, 2003).

The Steering Group then refined these objectives to express the need to achieve long-term competitiveness in response to new opportunities, and to improve the quality of life. The goals of TEP were defined as:

1) Contribute to a national innovation strategy based on a comprehensive analysis of:
    - Technological development,
    - World market opportunities (new markets and market niches),
    - Strengths and weaknesses of the Hungarian economy and R&D system.
2) Help Hungarian firms improve their competitiveness by providing the results of the above analysis.
3) Strengthen the formal and informal relationships among researchers, business people and civil servants.
4) Spread cooperative and strategic thinking.
5) Support integration into the European Union.
6) Formulate recommendations for public policies (Havas, 2003).

The objective of ‘supporting the integration to the European Union’ is quite similar to one of the motivations behind the Turkish foresight, as we will explain in Chapter IV.

TEP was a holistic foresight study, based on panel activities that incorporated the formulation of visions, the conducting of SWOT analysis, the devising of policy recommendations, a large-scale Delphi survey and a macro-scenarios approach.

TEP was conducted in three stages, namely, pre-foresight (about 6 months), main foresight (about 2 years) and dissemination and implementation (from June 2000 onwards) (UNIDO, 2005b). As it is usually common practice in national foresight exercises, various awareness seminars were held across the country to promote this new concept among experts and professionals during the pre-foresight phase. Furthermore, it was decided to establish the following panels as result of discussions in the steering group in the pre-foresight phase:

1) Human resources (education and employment).
2) Health.
3) Information technologies, telecommunications, media.
4) Natural and built environment.
5) Manufacturing and business processes (new materials and production techniques, supplier networks, globalization, etc.).
6) Agribusiness and food.
7) Transport (Havas, 2003).

It can be seen that the panels were organized with an emphasis on broad socio-economic issues, integrating many issues under the same panel topic, rather than in accordance with the logic of science and technology push of separating the panels along scientific branches. The panel leaders and secretaries were elected by the steering group and panel members in turn were elected by the panel leaders from nominations collected earlier in the consultation process (Havas, 2003).

The main foresight phase included the work of the panels, the implementation of the Delphi survey and scenario analysis. The work of the panels included the examination of major developments in their respective fields and devising alternative visions for possible futures. The panels also formulated the statements for the two-round Delphi survey. The panels were given great autonomy in line with the bottom-up approach that had been preferred. Still, some workshops were organized for the training of panel members and a methodological guidelines document as well as a template for panel reports was issued. The final panel reports included a critical assessment of the present situation, alternative futures (visions) and recommendations for achieving the most desirable and at the same time still feasible future in line with this template (Havas, 2003).

Within the main foresight phase a two-round Delphi survey was conducted whose administration, including the co-nomination procedure of the experts to participate had been contracted to a company in consequence to a public tender. Havas (2003) implies that foremost care was taken in the preparation of the Delphi statements and several revisions were made before the questionnaires were completed. A pilot study with 5-7 respondents who were not panel members was conducted for each questionnaire to ensure that the Delphi statements were comprehensible. It needs to be mentioned here that in the Hungarian Delphi survey, the Delphi statements dealing with non-technological issues exceeded the number of the technological Delphi statements, where non-technological Delphi statements refer to those addressing issues such as 'risk factors', 'institutions', 'regulation', 'human resources' etc. (Havas, 2003). The Delphi questionnaires consisted of 60-80 statements each and included the following questions:

1) Degree of expertise of the respondent.
2) Assessment of economic and social impact, and impact on natural environment.
3) Period within which the event/development will have first occurred.
4) Hungary's current position versus advanced European countries in the following four respects: S&T capabilities, exploitation of R&D results, quality of production or service and efficacy of regulation.
5) Constraints: social/ethical, technical, commercial, economic, lack of funding, regulatory standards, education/skill base.

6) Promotion of development, application: domestic R&D, purchase of license, know-how or ready made products (Havas, 2003).

In the first round of the Delphi survey, 1400 questionnaires were returned but in the second round the response rate was disappointingly low, remaining at 50 to 60 %. The Delphi survey results were used by the panels in their final reports (Havas, 2003).

An interesting point about the Hungarian foresight study was the usage of scenarios. Until that time, macro scenarios had not been developed in any other country engaged in foresight activities. In the beginning of TEP, it was only planned to use scenarios at panel level. In the course of the exercise though, it became evident that there was a need to develop scenarios at a macro level as well. Given the turbulent economic and social conditions of the country at that time, the panels had realized the difficulties of building their own visions and were requesting the definition of socio-economic framework conditions as a point of reference. Consequently, after intense discussions in the steering group and various workshops held on the subject with the participation of panel leaders, three macro visions were developed, with ‘global setting’ and ‘strategy’ as major variables (Havas, 2003). These are given in Table 3.3.

We will not elaborate further on these visions except to note that the policy recommendations in the final steering group report were aimed at facilitating the ‘Cooperative Partnership’ case (Havas, 2003).

After the macro-scenarios had been designed, the task to harmonize these with the visions or meso-scenarios of the panels posed another difficulty. While the panels had to analyze a certain field, with its specific structure (actors, institutions, norms, values and attitudes) and socio-economic and technological dynamics, the macro visions naturally dealt with issues at a higher level. At this point, a study to analyze the relationships of the various scenarios was conducted and discussions were held upon which some existing panel visions were revised and new ones were developed. Nevertheless, the harmonization was achieved at different levels for every panel. While ‘Agribusiness and Food’ and ‘Transport’ panels achieved a rather close correspondence, the others either partially aligned their futures with the macro scenarios, or developed quite context-specific structures.

Table 3.3: Three Macro Scenarios in Hungarian Foresight Program

	Active strategy	**Drifting (no strategy)**
No major changes in the global settings (values, norms, and operation of large corporations and major international organizations).	*Co-operative partnerships:* Hungary implements an active strategy characterized by strong integration, based on mutual benefits and high level of knowledge intensity.	*Drifting:* Hungary, having no strategy, is ‘grabbed’ into the current system of the international division of labor along a low-skills, low-wages path.
Fundamental, structural changes occur in the global settings.	*Alternative development:* Hungary is integrated into a new, ‘green’ world by pursuing an active strategy along a knowledge-intensive way.	

Source: Havas (2003)

Havas (2003) concludes that those that deviated most were the panels with the least economic kind of inherent logic such as ‘Human Resources’, ‘Health and Life Sciences’ and ‘Natural and Built Environment’, although even these panels had paid attention to the variables of the macro-visions. Ultimately, the macro scenarios approach had been useful but had also caused great difficulties, which according to Havas (2003) can be attributed to the endurance of the planning ‘mode’ in people’s mindset - not all participants were ready to understand the difference between ‘planning’ and ‘vision building’.

Among the activities in the dissemination and implementation phase of TEP, Havas (2003) lists the discussion and favorable reception of the final reports including the policy recommendations, by parliamentary committees. Yet, the enactment of a new health program and a new scheme for human resources development appear to be the only two examples given by Havas (2003) that demonstrate the programs’ link to implementation. Although the process benefits are hard to measure, TEP seems to have yielded those more efficiently as, by the end of the year 2000; more than one hundred regional workshops had been organized to discuss the results of TEP. Nevertheless, Havas (2003) concludes that the implementation could have been faster, more extensive and better coordinated, had there been stronger political support.

3.3 Concluding Remarks

In Chapter III we have reviewed international evidence on foresight in action. Two cases, the French and Hungarian foresight studies which greatly differ in rationale, objectives and methodology, were examined.

The first example was the French foresight study, which incorporated a 'critical technologies' approach that differs greatly from the Hungarian foresight as well as the Turkish technology foresight. The time horizon of the French foresight was five years, whereas the Hungarian foresight tried to look fifteen years ahead. The time horizon of the Turkish foresight study, Vizyon 2023, was 20 years, as will be explained in Chapter IV.

The French foresight study sought to identify priorities in a more narrowly defined S&T context and was focused on correctly determining a list of key technologies from the market as well as scientific / technological perspectives. Yet, 'large participation' and 'process effect' were also important concerns.

The Hungarian Foresight study bears resemblance to the Turkish foresight in its holistic approach. Except for the macro-scenarios used in the Hungarian foresight, the use of methodology is quite similar. However, the Hungarian foresight was more focused on addressing broad socio-economic issues and developing policy recommendations rather than identifying technologies. The selection of panel topics and the Delphi statements shows this concern. As we will see in Chapter IV, the Delphi statements in the Turkish foresight study were strictly technology statements, while in the Hungarian Delphi, the statements dealing with non-technological issues comprised the majority.

In the Hungarian foresight, the use of macro scenarios was not initially planned, but developed during the foresight when the need became evident. In the Turkish foresight study, vision-building was done at panel level, although the need for a macro-vision was expressed by some panels during the foresight process (See Section 4.4.2.2.5.2).

The conclusion reached here is that there is no standard approach or methodology for conducting foresight on a national level, but, the foresight can be designed in accordance with the needs of the country. In the following Chapter IV, we will examine the Turkish technology foresight, Vizyon 2023, in terms of process, methodology and results.

CHAPTER IV

THE TURKISH TECHNOLOGY FORESIGHT

4.1 A Brief History of Turkish Science and Technology Policy

National technology foresights are closely related to the process of forming science and technology (S&T) policy in countries. It is therefore important to understand the S&T policy background and context under which the Turkish Foresight Program was started. A chart showing the important milestones of Turkey's S&T policy efforts including major establishments, policies, plans and milestones is given in Figure 4.1.

Turkey recognized the importance of S&T as a driver of economic growth and welfare very early and became an OECD member country in the year 1961. First attempts of policy work took place under the umbrella of the OECD. Turkey participated in the OECD Pilot Teams project alongside Greece, Spain and Portugal, Ireland, Italy and the former Yugoslavia. Pilot Teams were formed by each country to investigate how R&D could be related to production and social welfare at national level in developing countries under the framework of policies and plans aimed at increasing economic growth (Göker, 2002; Türkcan, 1998).

The planned era in Turkey started in 1963, a date which also coincides with the establishment of the Scientific and Technical Research Council of Turkey, TÜBİTAK. From then on, development plans were made by the State Planning Organization (DPT) in 5-year intervals. At present, the ninth development plan is in preparation.

Tümer (2003) describes the early 60's to late 80's as the 'naive' period of Turkish S&T policy when the main trends of the developed industrial economies were followed from 20 years behind.

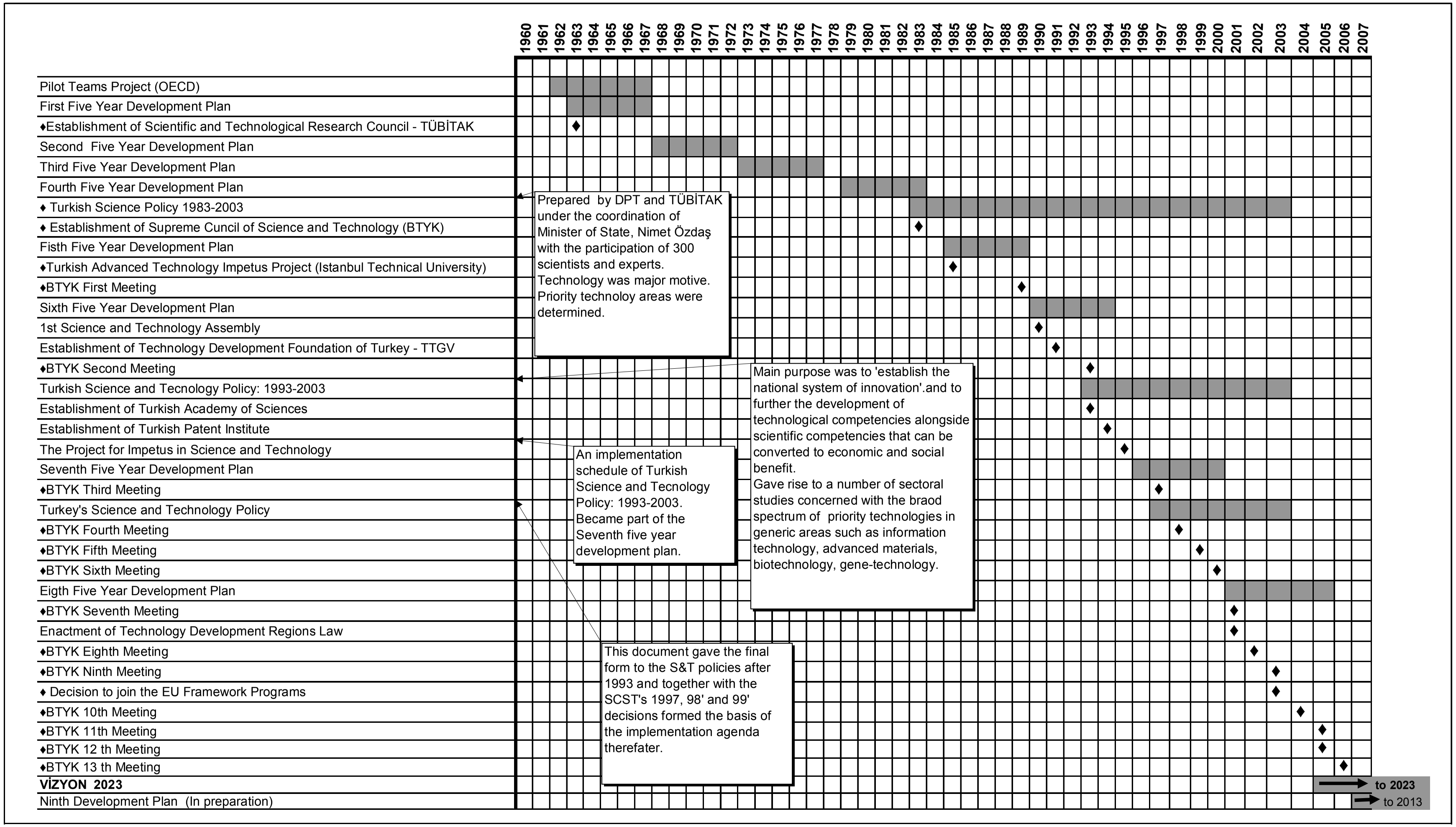


Figure 4.1: A Timeline of Turkey's S&T Policy-making and Planning - Major Polices, Plans, Establishments And Milestones

Turkey's first detailed S&T policy document 'Turkish Science Policy: 1983-2003' was prepared in 1983 with the contribution of over 300 experts under the coordination of the Ministry of State. This document explicitly recognized the role of technology in development and can be regarded as the first attempt towards defining 'critical technologies' in Turkey. In consequence of this policy document, a new institution, the Supreme Council of Science and Technology (BTYK) was created in 1983 as the highest S&T policy-making body. The council was to be chaired by the Prime Minister and was to enable the design of S&T policies with the participation of S&T-related ministers, high level bureaucrats, technocrats and representatives of non governmental organizations. The decisions of the BTYK are not of legally binding but of advisory nature to the Government. BTYK had its first operational meeting only in 1989 and started to serve its purpose in formulating the national S&T policies from 1993 by approving the document entitled 'Turkish Science and Technology Policy: 1993-2003' in its second meeting (Tümer, 2003; BTYK, 1993). In the meantime, another policy document had been prepared in 1985, on request of the Government by the Istanbul Technical University, but was never implemented (Göker, 2002).

'Turkish Science and Technology Policy: 1993-2003' represents a paradigm shift from 'building a modern R&D infrastructure' to 'innovation oriented' national policies. In 1995, 'The Project for Impetus in Science and Technology', was formulated to elaborate this policy and was included as the S&T chapter in the Seventh Five Year Economic Development Plan. This policy suggested the following seven priority areas of S&T:

- Information and communication
- Flexible manufacturing and automation
- Transportation with particular interest in rail transport
- Aeronautics, space and defence
- Genetic engineering and biotechnology with particular emphasis on the agricultural applications in relation with the "South Anatolian Project"

- Environment friendly technologies and renewable energy systems
- Advanced materials

An eighth priority area related to earthquake research was added after the 1999 disasters (Tümer, 2003).

In 1997 BTYK approved another document - ‘Turkey's Science and Technology Policy’. This document gave the final form to the S&T policies after 1993, and together with the BTYK's 1997, 1998 and 1999 decisions formed the basis of the implementation agenda thereafter (BTYK, 1997; BTYK, 1998; BTYK, 1999; Göker, 2002). The amendments made in 1998 and 1999 were directed towards establishing the national system of innovation.

4.2 The Policy Context of the Vizyon 2023 Project

The technology foresight was started as part of the effort to design a new science and technology policy for Turkey. As the latest policy in force, ‘Turkish Science and Technology Policy 1993-2003’ was due to come to an end, BTYK on its sixth meeting on December 2000, took the decision to create a new national science and technology policy for the period of 2003 to 2023 for Turkey (BTYK, 2000, p. 14). This decision was accompanied by the preliminary project proposal for the preparation of a strategy document. The preliminary project proposal comprised of 5 sub-projects - a long-term ‘technology foresight’ sub-project, the ‘determination of Turkey’s technological balance of payments’ sub-project, ‘monitoring the national innovation system and determining the mechanisms for creating incentives’ sub-project, ‘inventory of Turkey’s researchers’ sub-project and the ‘evaluation of Turkey’s R&D systems’ organizational infrastructure with an analytical inventory of the existing legislation’ sub-project. For all proposed sub-projects, TÜBİTAK was assigned the task of project coordinator (BTYK, 2000, pp. 13-24).

In pursuit of this task, TÜBİTAK started its preparations by first examining the science and technology policies made in Turkey and their implementation until then. It was believed that the success of the new policy would as well depend on a clear comprehension of the previous experiences and the mechanisms that had led to their failure or success. The study led to the conclusion that although the previous policies produced some beneficial results and improvements, the targets were missed by far. One of the main reasons that had led to this failure was attributed to lacking social support and lacking ownership of the political authority. Furthermore, it was determined that science and technology policy issues should not be treated in isolation but required a holistic approach, one that links them to social and sectoral policies and the national innovation system (TÜBİTAK, 2004c, pp. 8-10). Thus, the design of the process towards the creation of a new science and technology policy was dominated by the search for methodology that would relate policy to social and economic needs while at the same time eliminating the disadvantage of lacking commitment experienced thus far. The preparatory phase took about a year and included the examination of the science and technology policies of many other countries and the methods of devising these. As a result of this effort, the 'Vizyon 2023: Science and Technology Strategies' project based on technology foresight as its essential component was detailed and presented to the BTYK on its 7th meeting in December 24, 2001 (BTYK, 2001, p. 9). The project scope was altered from the preliminary proposal, so that there now were 4 sub-projects included: Technology Foresight, National Technology Inventory, R&D Human Resources and National R&D Infrastructure.

Besides the need for a new S&T strategy, Turkey's candidacy to the European Union (EU) has been an essential driver of the Turkish foresight efforts throughout. Both BTYK decisions of December 2000 and December 2001, address this issue. The decision to join the EU Framework Programs, taken by the Supreme Council in December 2000 (BTYK, 2000, p. 25), coincides with the decision to create a new S&T policy for Turkey. The December 2001 meetings' decisions point out that technology foresight is utilized as a policy tool to devise long-term S&T policies worldwide and that foresight programs have either been already completed or are ongoing in almost all EU member and candidate countries - the implication being that Turkey had to emulate this course and base S&T strategy on foresight (BTYK, 2001, p. 9).

The rationale of the initial BTYK decision of December 2000 taken with regard to the preparation of a new national S&T strategy points out that previous science and technology policies bear the characteristic of adopting the goals of developed countries to Turkey and are not based upon any technological foresight. It was therefore deemed necessary to develop new strategies based on foresight that also incorporate alternative scenarios for Turkey (BTYK, 2000, p. 13). The preliminary project proposal for the preparation of the new national S&T strategy entails that an 'action plan' for Turkey covering the period 2003-2023, based on at least three alternative scenarios be developed (BTYK, 2000, p. 15). This 'scenarios approach' that was initially intended does neither appear in the BTYK, nor in the TÜBİTAK documentation any further and there is no clue as to why it was later dropped from the agenda.

The initial proposal furthermore includes the forming of a steering committee that will supervise the projects' progress. TÜBİTAK is designated to serve as the secretariat to this committee and is assigned the task of project coordinator while the State Planning Organization, DPT, is designated as a supporting organization (BTYK, 2000, p. 15). TÜBİTAK, the State Planning Organization (DPT), The State Statistics Institute (DIE), The Turkish Academy of Sciences (TÜBA), The Turkish Technology Development Foundation (TTGV) and The R&D Department of the Ministry of Defense (MSB/ARGE) are designated as the projects' executing organizations.

In the 2001 BTYK decisions where the final form of the project with respect to the preparation of the strategy document was approved, TÜBİTAK is designated as the 'responsible' organization and the organizations that later comprised the steering committee are mentioned as 'associated' organizations.

4.3 The Major Theme and Organization of the Vizyon 2023 Project

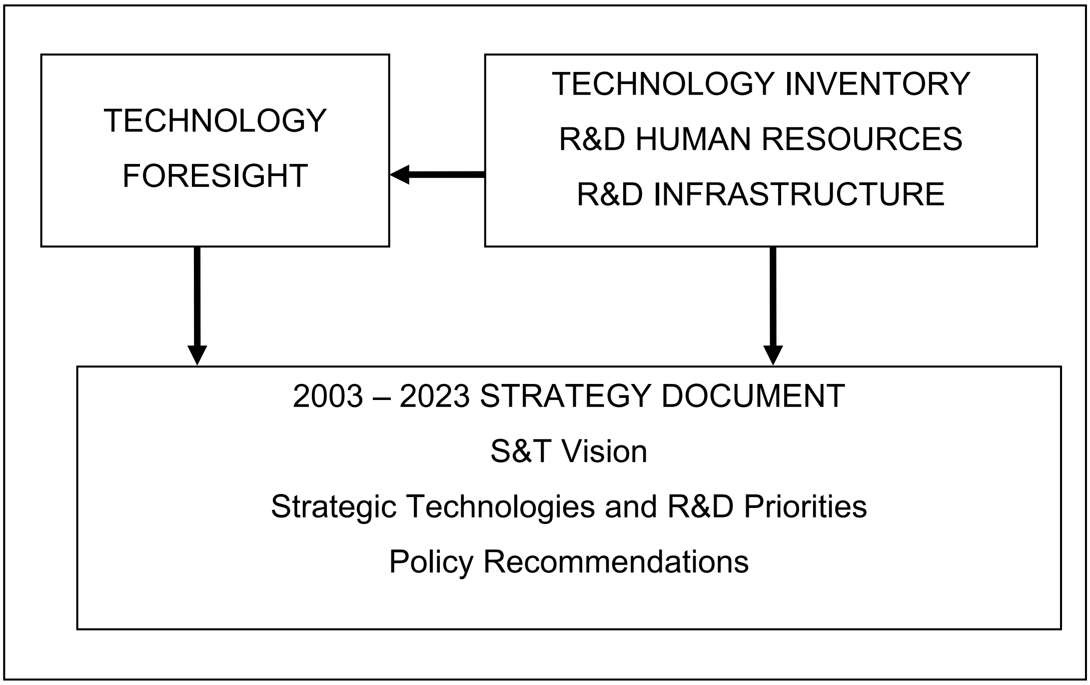
The major theme of the Vizyon 2023 Project, as stated in various documents of TÜBİTAK, was to create a welfare society that,

- dominates in science and technology,
- has the awareness of using technology and is capable of producing new technologies,
- has the ability to convert technological progress to social and economic benefit,

in line with Atatürk's goal to reach the contemporary level of civilization by the year 2023, the 100th anniversary of the Republic (TÜBİTAK, 2004c, p. 11).

As shown schematically in Figure 4.2, the Vizyon 2023 project was comprised of four sub projects – 'Technology Foresight', 'Technology Inventory', 'R&D Human Resources' and 'R&D Infrastructure', whereby the latter 3 subprojects were aimed at collecting and evaluating data on the science, technology and human resources bases of the country. The purpose of the technology inventory sub-project was to determine the level of national technological competence in accordance with international norms, whereby technological competence was understood to comprise of the abilities to effectively use existing technologies (production capability), choose the most appropriate technology under given circumstances (investment capability) and to develop new technologies (innovation capability). This sub-project was implemented by collecting data via questionnaires, planned to reach a total of about 2500 firms in the manufacturing industries. A final report has as yet not been issued.

The R&D Human Resources project was aimed at determining and evaluating the researchers' base in Turkey and resulted in the establishment of a web-based information system (ARBIS) where researchers can register to submit their scientific profiles. Likewise, the purpose of the R&D infrastructure project was to gather data about the countries' systems and equipment stock used in R&D. A web-based system (TARABIS) was generated to enable organizations to input data and query information.



Source: TÜBİTAK (2004c, p. 11)

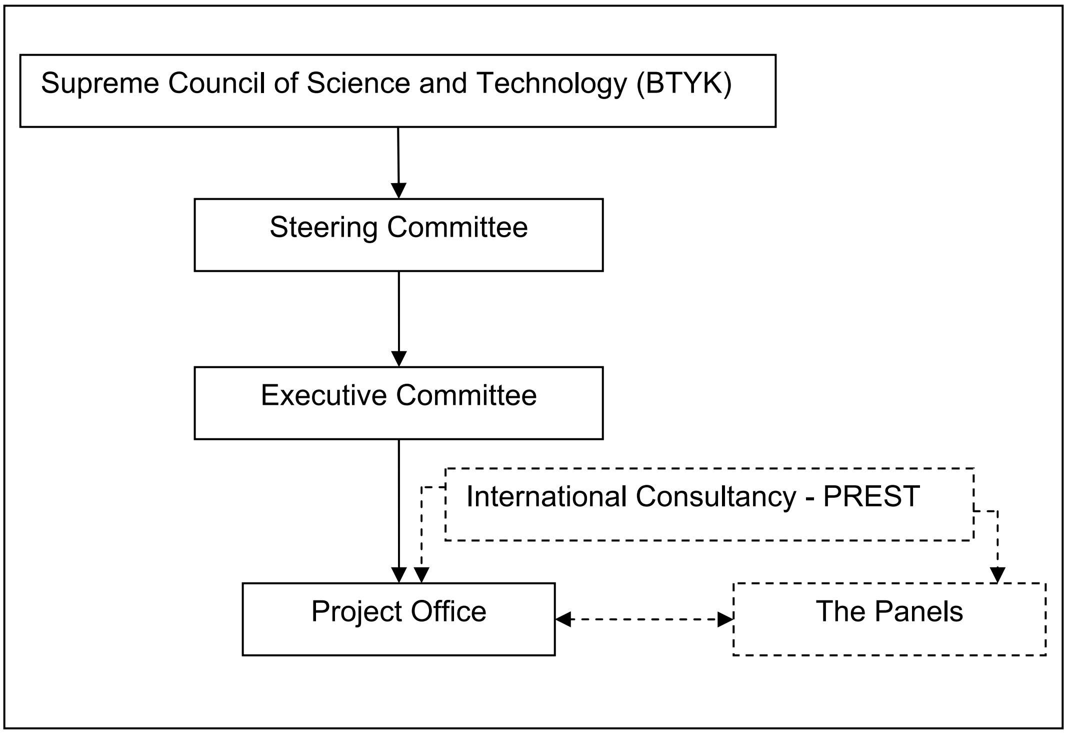
Figure 4.2: The Vizyon 2023 Subprojects and Their Interaction

Figure 4.2 suggests that the three other subprojects were supposed to provide input to the technology foresight project and to the formulation of the strategy later on, but there is little evidence to what extend this was accomplished during implementation.

The organization scheme of the Vizyon 2023 project is given in Figure 4.3. (The dashed boxes illustrate those bodies that are related to the Vizyon 2023 Technology Foresight sub-project only).

The steering committee was established with the participation of 27 governmental organizations (including several related ministries and governmental offices, the Turkish General Staff, The General Secretariat of the National Security Board, the Council of Higher Education, The State Planning Organization, the Undersecretariats of Treasury, Foreign Trade and

Defense Industry, the Secretariat General for the EU Affairs, The Turkish Academy of Sciences, State Statistics Organization, Small and Medium Industry Development Organization and the Telecommunication Board) 29 non-governmental organizations, professional associations and chambers and 9 universities.



Source: TÜBİTAK (2004c, p. 12)

Figure 4.3: The Organization Scheme of the Vizyon 2023 Project

The executive committee comprised of members from the higher management of TÜBİTAK, the State Planning organization (DPT), the Undersecretariat of Defense Industry (SSM) and the Turkish Technology Development Foundation (TTGV) (BTYK, 2003, p. 10). The TÜBİTAK documentation includes little reference to the work and performance of the executive committee but mentions the meetings of the steering committee and the work of the project office. Given the available documentation, it is not possible to decide to what extend there was coordination between these organizations in the implementation of the project later on.

4.4 The Vizyon 2023 Technology Foresight Project

The technology foresight project comprised the backbone of Vizyon 2023 and was the first of its kind in Turkey. The primary objective of the Vizyon 2023 project was to implement a technology foresight exercise and use its results as a basis for the design of Turkey's new science and technology policy. Process benefits such as 'large participation', 'strategic thinking', 'forward concentration', 'coordination', 'obtaining social support and consensus' were also sought and considered particularly useful in gaining support for he later implementation of the policy that would thus be developed.

The project budget was detailed in the BTYK 8th meeting decisions. The total budget allocated for the years 2002 and 2003 was 3.1 Million YTL including personnel expenses (BTYK, 2002, p. 8).

The technology foresight project was supported through international consultancy provided by the Policy Research in Engineering, Science and Technology Institute of the University of Manchester (PREST) under the financial sponsorship of the British Council. Prof. Denis Loveridge and Dr. Michael Keenan of PREST were engaged as consultants to the Turkish technology foresight for the period of September 2002 to December 2003 (TÜBİTAK, 2004c, p. 30).

4.4.1 The Methodology Used

In Chapter II, we had explained that foresight activities evolved in three generations. The Turkish technology foresight exercise exhibits the elements of a second generation foresight exercise where the objective is to determine the requirements of socio-economic sectors and the scientific and technological capabilities needed to meet these objectives. This is the framework chosen by many countries that have undertaken national foresight exercises for the first time in the 1990's. Accordingly, it was decided to establish expert panels in relation to all socio-economic fields of importance to Turkey. The resulting expert panels covered 10 socio-economic (sectoral) fields and 2 thematic fields and were each comprised of about 20-25 experts form public organizations, the industry, universities and NGO's. In parallel to the expert panels, a two-round Delphi survey was conducted. In fact, the two methods were interactively used. The expert panels prepared the Delphi statements and the result of the Delphi Survey contributed to the preparation of the expert panel final reports and the roadmaps of each technological activity topic. The practice of thus interweaving the Delphi Survey method with expert panels in the Turkish foresight model is considered as a first of its kind approach that has also invoked much international interest (TÜBİTAK, 2004c, p. 20).

4.4.2 The Technology Foresight Process

The technology foresight process can be examined in two phases, the 'pre-foresight phase' and the 'foresight phase'.

4.4.2.1 The Pre-foresight Phase

The pre-foresight phase started upon BTYK's decision to prepare the new S&T strategies document and the assignment of TÜBİTAK. Within the pre-foresight phase the foresight studies of the United States of America (USA), Australia, South Africa, Holland, The United Kingdom (UK), Ireland, Japan, Korea and the EU's Futures and Enlargement Futures project were examined. The result of this study was compiled in a working paper (TÜBİTAK, 2001).

Among several other studies that were completed within the pre-foresight phase, the study of Durgut et al. (2001) that proposes a model for the Turkish Foresight Exercise deserves particular mentioning. Herein, Durgut et al. (2001) upon revising the history of the S&T policy context in Turkey, decide that previous S&T policies, particularly the sectoral studies after 1993 are in lack of sharing a common vision of Turkey's long-range socio-economic and political goals. This lack is attributed to the political authority in assigning only a minor role to 'strategic planning' and to S&T as a variable in strategic planning for solving socio-economic problems and reaching long-range socio-economic goals. Consequently, the sectoral priorities that were determined were void of the systemic coherence that would have been provided by sharing a common vision. What's more important, not even generally valid predictions were converted into decisions and adopted by the political authority. (Durgut et al., 2001). Further to this analysis, Durgut et al.'s model proposes an organizational structure for the foresight exercise, including a project group, under which a project core group, a methodology group, a concepts group for maintaining coherence in core concepts used in social approaches and scenarios development and a project promotion group should be established. As to the foresight process, the model suggests to employ a top down approach by starting with the formulation of the vision, followed by the determination of the major themes that are connected to it. The next steps include the definition of socio-economic fields and the establishment of the related panels, the definition of alternative scenarios by each panel, SWOT analysis, Delphi survey's and a 'strategy group' to wrap up the panels' findings and determine the implementation agenda to follow. Although suggesting the use of scenarios, the model does not provide any detail on how this should be accomplished. Even though this model proposal was more sophisticated than the later actual implementation; the Turkish foresight exercise has to a great extent benefited from the framework drawn therein.

The pre-foresight phase also included various activities and meetings. To mention are the 'Kritek 2001', Critical Technologies Symposium, among others with the participation of OECD's and The European Commission's 'Futures' Project officials and Turkish researchers. This symposium was a platform for collecting ideas and introducing the project publicly to the local and international communities. Furthermore, 2 meetings were held at TÜBİTAK with the objects of introducing and promoting the Vizyon 2023 project countrywide, informing about the ongoing preparations and collecting suggestions and opinions from the participants invited from many governmental and non-governmental organizations.

By the beginning of the year 2002, the object, scope and method of the Vizyon 2023 project had been defined, presented to and accepted by

BTYK. The project office was formed and the project actually started. The design of the process was completed after a foresight workshop organized shortly thereafter in March, 2002. During this workshop with the participation of 45 experts with experience in S&T policy and foresight, suggestions with regard to the proposed method, the structure of the panels, their work definition and the project schedule for Vizyon 2023 were collected. Furthermore, the areas of panel formation and the criteria for determining the strategic technologies were discussed (TÜBİTAK, 2004c, p. 23).

4.4.2.2 The Foresight Phase

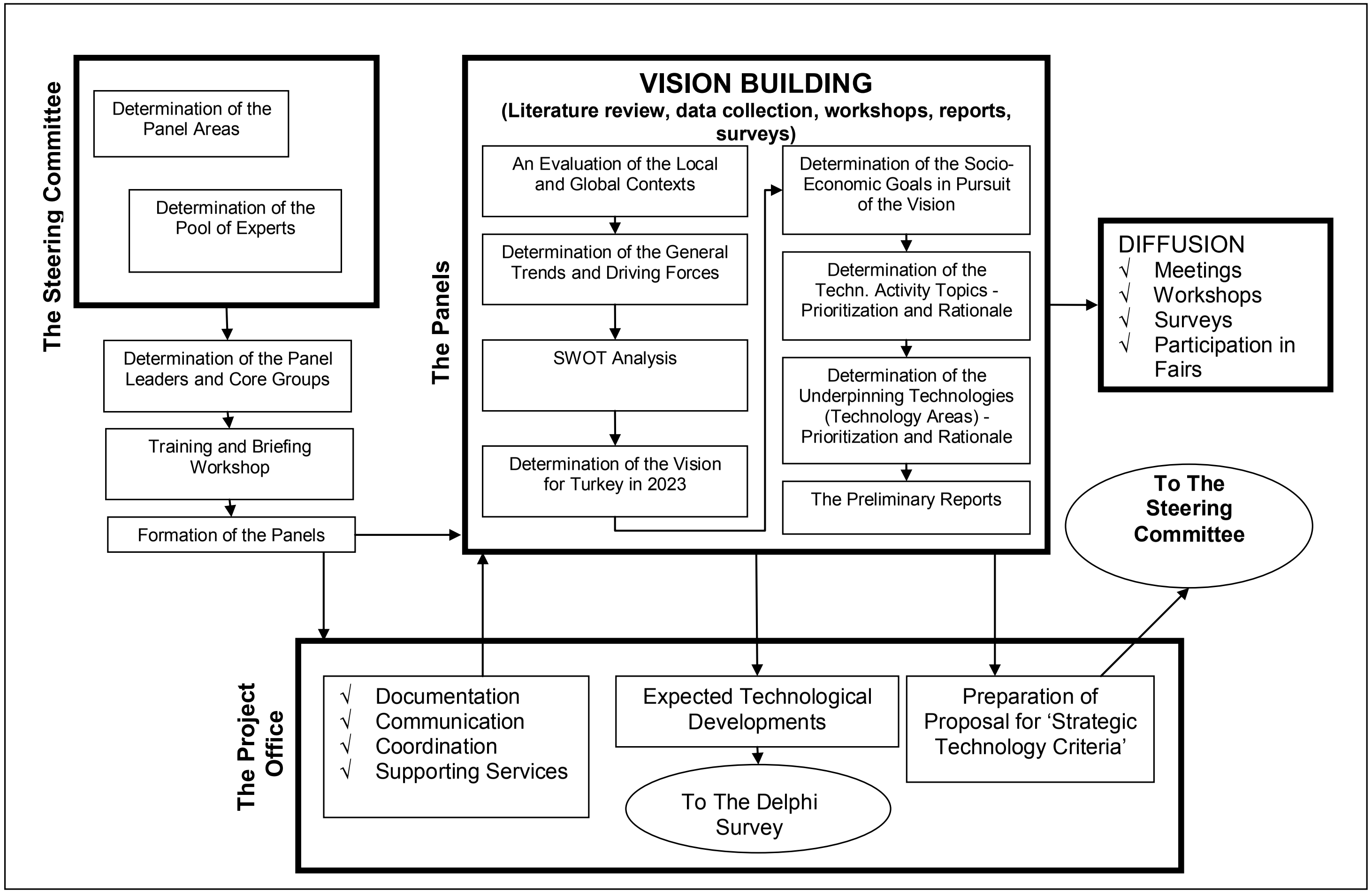
The various steps involved in the foresight phase are shown schematically in Figures 4.4 and 4.5. The foresight phase started with the first meeting of the Steering Committee where the socio-economic fields for the panels were determined. The project office exemplified to the steering committee a broad list covering the fields compiled from the other countries' foresight studies. It was decided that the steering committee would make the selection for the Turkish foresight project in accordance with the following principles:

- To select sectors that may develop within the next 20 years and in which Turkey has the potential to develop competitive advantage besides those that Turkey is considered to have competitive advantage already,
- To select sectors which are considered to be affected by S&T and S&T policy. (In other words to exclude sectors where the sector's problems and its competitiveness does not depend on S&T and S&T policy but for instance only on fiscal policies),
- To limit the number of socio-economic fields to 8-10, due to practical concerns (TÜBİTAK, 2004c, p. 23).

The following list of 12 socio-economic fields for expert panel formation emerged by using interactive group techniques. (In the original listing there was a combined chemicals and textiles panel which in the later course of the project was divided into two panels)

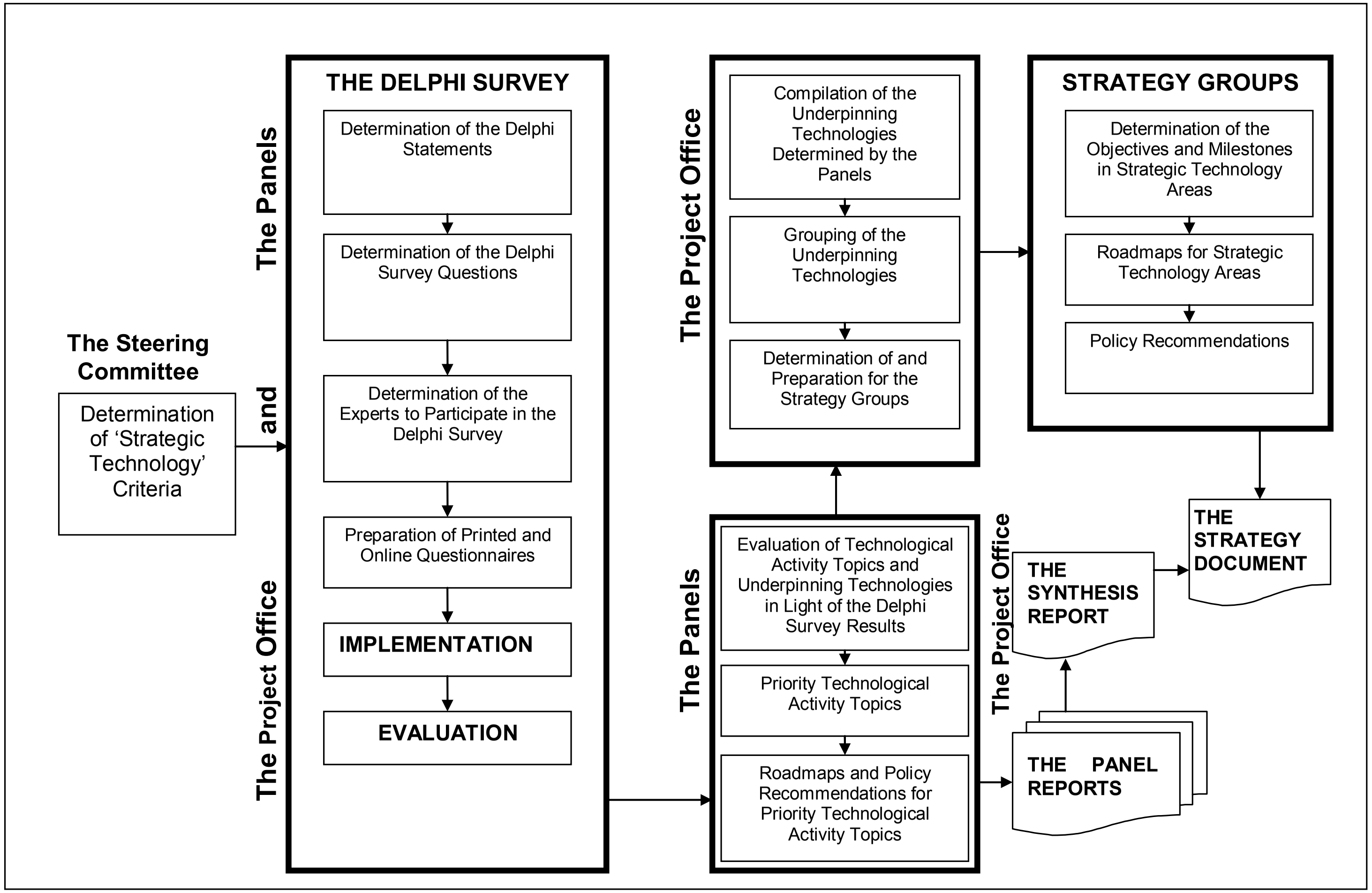
1) Education and Human Resources (Thematic Panel)
2) The Environment and Sustainable Development (Thematic Panel)
3) Information and Communication
4) Energy and Natural Resources
5) Construction and Infrastructure
6) Chemicals
7) Textiles
8) Machinery and Materials
9) Health and Pharmaceuticals
10) Defense, Aeronautics and Space
11) Agriculture and Food
12) Transportation and Tourism

The members of the expert panels were chosen by way of nomination from the organizations that were members of the steering committee. Thereby, an experts pool including the names of more than 1000 experts was created. The executive committee selected from this pool, a panel leader and a core group of 3-4 members for each panel. The core group of each panel included a member of the project office in order to maintain a direct link to the project office. The panel leader had the responsibility to establish the panel, orient the panels' work with the guidance of the project office and prepare the panel reports in accordance with the pre-determined formats.



Source: TÜBİTAK (2004c)

Figure 4.4: The Technology Foresight Process – 1



Source: TÜBİTAK (2004c)

Figure 4.5: The Technology Foresight Process - 2

The core group members of the panels participated in various meetings organized by the project office and took part in the decision making processes concerning the implementation of the project (TÜBİTAK, 2004c, p. 27). The lists of the panel members are given in Appendix A.

The first meeting of the core groups of the panels took place in June 2002. Participants were informed about general concepts of S&T policy and technology foresight, the description and process of the Vizyon 2023 project and the various techniques used in technology foresight. Subsequently the 'Foresight in Action' workshop was conducted, where the experiences of the Czech Republic, South Korea, and the United Kingdom where introduced to the participants by renowned speakers - Karel Klusacek, Taeyoung Shin, and Michael Keenan. Furthermore, the object, scope and method and the planned work was presented to the panel members and discussed with the participation of the foreign experts. Upon conclusion of these meetings the panel leaders and core groups chose the panel members from their pool of experts and the panel meetings commenced, the first one being the Construction and Infrastructure Panels' meeting in July 2002 (TÜBİTAK 2004c, p. 28).

With the feedback received from these meetings the project office finalized the job description of the panels and the resulting document was distributed to all panel members (TÜBİTAK, 2004c, p. 28). According to this document the panel work was structured into the following four phases:

- Phase 1 - Vision Building (July 2002-January 2003)
- Phase 2 - Diffusion (February 2003-March 2003)
- Phase 3 - The Delphi Survey (March 2003-June 2003)
- Phase 4 - Road Maps and Policy Recommendations (May 2003-July 2003)

4.4.2.2.1 Phase 1 - Vision Building

The framework drawn for the panels to be used in the vision building phase involved the following steps:

- An assessment of the technological and economic conditions and structure of the socio-economic sector.
- The determination of general trends and the main drivers of change within the next 20 years.
- SWOT analysis.
- The creation of the vision for Turkey, envisaging the year 2023.
- Determination of the socio-economic goals in pursuit of the vision.
- Determination of the technological activity topics necessary to reach the socio-economic goals.
- Determination and prioritization of the technology areas (underpinning technologies) that endorse the technological activity topics. (TÜBİTAK, 2004c, p. 28).

Although the panels were recommended to adhere to this procedure, they were free to choose their individual methods in the implementation. It had been anticipated that different approaches would arise in each panel as a result of the different structures of the socio-economic sectors and the composition of panel members with different areas of interest. This actually turned out to be the case. For instance, the 'Machinery and Materials', 'Transportation and Tourism', 'Health and Pharmaceuticals' panels organized their work by dividing panel members into certain sub-groups. This difference of approach was welcomed since the technology foresight exercise was deemed to be a learning process for all participants and the experiences gained would serve to establish proper methodologies in subsequent foresight exercises to be conducted in Turkey.

During the vision-building phase the panels held a total of 132 meetings. A second general meeting with the core group members was held in November 2002. In this meeting a member of each panel's core group made a presentation about the panel's progress of work, the methodology used and the vision that had been created. Furthermore, discussions were held on the further course of the technology foresight exercise. The vision building phase ended with the conclusion of the preliminary panel reports and their submission to TÜBİTAK in January 2003 (TÜBİTAK, 2004c, pp. 30-31).

4.4.2.2.2 Phase 2 - Diffusion

The technology foresight project intended that all segments of society take actively part in the shaping of the country's goals, policy and strategy in science and technology. This broad participation would ensure that the policies and strategies formed would be adopted more widely and had a better chance of being implemented than it had been in previous cases. Therefore, it was considered essential that the panels' work should be discussed publicly before being concluded. Accordingly, a public discussion was opened after the posting of the preliminary panel reports on the TÜBİTAK web-site and a press-conference held at TÜBİTAK in January 2003. Again, the diffusion process differed from panel to panel and various methods of gaining public attention, such as participation in exhibitions, meetings and workshops were employed. A complete listing of organizations and events that took place within the diffusion phase is provided in the TÜBİTAK documentation (TÜBİTAK, 2004c). The project office also engaged in activities related to the introduction of Vizyon 2023 in Turkey as well as internationally, throughout the projects' whole implementation phase. Some examples would be participation in the 'eForesee Workshop on Foresight Basics' in June 2002 in Malta, a presentation made for the Grand National Assembly's Knowledge and Information Technologies Commission in June 2002, a presentation for the Turkish Industrialists' and Businessmen's Association (TÜSİAD) in June 2003, a session at the 'International Conference in Economics VII' in September 2003 in Ankara and various other meetings to introduce the project to Turkish governmental and professional organizations. Among the panels, the ‘Agriculture and Food Panel’ was the most active one in terms of the number of activities listed in the TÜBİTAK documentation and participated in many events organized by the Ministry of Agriculture. In contrast, there is no information on any activity from side of the ‘Information and Communication’, ’Machinery and Materials’ and the ‘Environment and Sustainable Development’ panels. Given for instance the importance of public involvement in environmental issues, it is then highly questionable whether the project was efficiently and successfully promoted in the public. The impression arises that the time allocated for the diffusion phase of two months might have been either too short or not used effectively.

4.4.2.2.3 Phase 3 - The Delphi Survey

The Delphi survey was conducted for the purpose of obtaining broad consultation on the technological developments forecasted by the panels. Besides using the survey results as input to the technology foresight process, the following benefits were expected from the Delphi survey:

- To share the findings of the panels with the private sector, the universities and public research organizations,
- To help establish the connection of scientific and technological developments to research and commercial products,
- To establish a reference for future research,
- To facilitate an interactive learning process to the participants,
- To create a means of comparison with other countries’ Delphi surveys (TÜBİTAK, 2004c, p. 65).

Except for the ‘Education and Human Resources’ panel which did not take part in the Delphi survey, questionnaires were prepared for each of the remaining 11 panels. As usual practice, the questionnaires consisted of the

Delphi statements (declarations about developments in science and technology as anticipated by the panel) and the Delphi questions that the participants were required to respond to for each Delphi statement.

4.4.2.2.3.1 Determination of the Delphi Statements

In order to determine the Delphi statements the panels were requested to express each technological development they would like to assess in the survey, in the form of a clear and unambiguous phrase. In order to maintain consistency and uniformity, the project office distributed a 'Delphi Survey Form' to the panels in a meeting with the panel core groups in February 2003 (TÜBİTAK, 2004c, p. 66). The panels presented the proposed Delphi statements on this form to the project office and the project office concluded the formulation of the Delphi statements to be included in the Delphi Survey after a series of meetings and consultations with the panel core groups in May 2003. As a result of this effort 413 different Delphi statements were formulated to be included in the questionnaires of the 11 panels. Some of the statements were used in more than one panels' questionnaire so that the number of statements overall included in the questionnaires was 517. Table 4.1 shows the number of Delphi statements per each panels' questionnaire.

There has been effort to keep the number of Delphi statements low since international experience had shown that limiting the number of Delphi statements to 40-50 would increase the number of respondents. But, since some panels such as 'machinery and materials' and 'agriculture and food' addressed a wide scope, this number was exceeded. Still, the Delphi statements could not cover all the predictions of the panels (TÜBİTAK, 2004c, p. 66).

Table 4.1: The Number of Delphi Statements per Panel

Panel	Number of Delphi Statements in Delphi Survey
Agriculture and Food	73
Machinery and Materials	67
Information and Communication	58
Chemicals	52
Energy and Natural Resources	47
Health and Pharmaceuticals	46
Defense, Aeronautics and Space	45
Textiles	40
Transportation and Tourism	33
Construction and Infrastructure	29
The Environment and Sustainable Development	27

Source: TÜBİTAK (2004c, p. 66)

4.4.2.2.3.2 Determination of the Delphi Questions

A participatory process was used to determine the Delphi questions by considering the specific needs of Turkey. To this end, a Delphi workshop with the participation of panel members, the project office and Dr Michael Keenan as the PREST consultant was conducted in February 2003. The format of the questions was finalized by the project office to comprise of the following 6 groups (TÜBİTAK, 2004c, p. 67):

Level of expertise: The respondent was asked to assess his/her expertise on that particular Delphi statement, on a range of 1 to 4, with 1 signifying 'no expertise' 2 – 'low expertise', 3 – 'adequate expertise' and 4 – 'high expertise'.

Present Situation: This group of questions was aimed at determining Turkey's current situation with respect to the sub-variables 'researcher potential', 'R&D infrastructure', 'competency in related basic science' ‘innovation capacity of firms’ and ‘existence of competitive firms’ related to the Delphi statement. The respondent was asked to vote on a scale of 1- 4 for each sub-variable representing ‘none’, ‘weak’, ‘sufficient’ and ‘strong’ respectively.

Beginning Competency: This question aimed to determine at which level of research amongst ‘basic research’, ‘applied/industrial research’, ‘pre-competition industrial development’ and ‘industrial development’ it would be necessary to start in order to realize the predicted technological development in the Delphi statement. The respondent was asked to choose one of these levels.

Policy Tools: The participant was asked to choose 2 policy measures among ‘R&D infrastructure support’, ‘R&D project support’, ‘start-up support’, ‘guided projects’ ‘human resources’ and ‘public procurement’ that are considered as most effective in the realization of the Delphi statement.

Realization Time: It was asked in which 5 year period the Delphi statement would be realized, provided that certain policies are implemented. The respondent was asked to choose one of the periods from 2003-2007, 2008-2012, 2013-2017, 2018-2022, 2023 and afterwards, or ‘can never be realized’.

Contribution to Turkey: This group of questions aimed to determine the contribution or effect to Turkey in terms of ‘competitive strength, ‘science, technology and innovation capacity’, ‘environment friendliness and energy efficiency’, ‘national added value’ and ‘quality of life’, should the Delphi statement be realized. The respondent was asked to vote on a scale of 1 - 4 for each criterion with 1 designating ‘no effect’ 2– ‘small effect, 3 –‘effective’ and 4 – ‘very effective’.

The sub-variables mentioned above in the final group of questions comprise the ‘strategic technology’ criteria. The strategic technology criteria were developed in the steering committees’ second meeting in April 2003. In the Delphi workshop in February 2003, a preliminary list of criteria for technology prioritization had been developed, which was used as a basis of further elaboration by the project office. The preliminary list that was presented to the steering committee included 13 criteria, to which 9 were added by the steering committee afterwards. These were grouped and resulted in the following list of 15 criteria (TÜBİTAK, 2004c).

- **Science, Technology and Innovation Capacity** – The contribution of the technology in terms of enhancing Turkey's capacity in science, technology and innovation processes.
- **Environment Friendliness and Energy Efficiency** – The contribution of the technology to solving environmental problems and sustain the environment, its, energy efficiency and productivity.
- **National Added Value** - The technologies' contribution to increase local production and the utilization of local resources.
- **Quality of Life** - The contribution to the life-span and the quality of life and welfare in the country.
- **Competitive Strength** - The technologies' contribution in increasing Turkey's share in local and international markets by increasing productivity especially in products and services with high added value.
- Economic Stability – The technologies' effect in terms of contributing to economic and social stability.
- Employment – The technologies' contribution to increasing employment rate, especially qualified employment.
- Cooperation (Networking) - The technologies' contribution to the creation of local and international cooperation.
- Public Service – The contribution to enhance health and education related and cultural activities in the public sphere.
- Self-sufficiency – The technologies' contribution in increasing the self-sufficiency of Turkey.
- Small and Medium Size Enterprise (SME) supporting – The technologies' ability to be used by SME's.

- Social Equality – The technologies' contribution to social justice and to reducing regional differences and being accessible for all individuals.
- Social and Cultural Acceptance – The technologies' conformance to social and cultural values.
- National Security – The technologies' contribution to national security issues.
- Diffusibility – The ability of the technology of being utilized within many socio-economic activities and sectors.

These criteria were prioritized through a voting in the steering committee. The first 5 criteria listed above received the highest votes and were thus determined to be the strategic technology criteria. It is of course open to discussion why for instance 'employment' or 'national security' did not make it to the list of 'strategic criteria' in a country with a very high unemployment rate and a relatively high budget for defense expenses. Nevertheless, the choice is justified through the open and participative approach of the steering committee where Turkey's most important and relevant organizations were represented.

4.4.2.2.3.3 The Delphi Survey Implementation

The Delphi Survey was implemented through printed questionnaires sent by mail to the experts and via a web-site on the Internet. The project office compiled a list of experts from the panels' nominations, experts from TÜBİTAK's research institutes, referees from TÜBİTAK's scientific journals, experts from firms that had applied for support to TÜBİTAK and the Technology Development Foundation (TTGV) and their referees. A list of 7016 experts, thus, resulted. The designated experts received per mail the printed questionnaires in their area(s) of expertise, a brochure introducing the Vizyon 2023 project and explanations about the Delphi technique and username and password for the web-site. Furthermore, universities, various professional and industrial organizations and NGO's were contacted and informed to call upon their members to participate. The experts were encouraged to answer the questionnaire via the web-site. The web-site was designed so that experts who did not receive an explicit invitation were also allowed to get a password and participate. All participants who chose to respond the survey via the website were able to access all questionnaires, prepare their individual Delphi Form by selecting key-words related to their areas of interest and were thus free to choose the Delphi statements they wanted to respond. This was internationally a first of a kind implementation.

The first round of the Delphi was carried out between May 14 to June 8, 2003 and the second round between June 18 and June 30, 2003. The result of the statistical evaluation of the first round was published on the project website on June 16, 2003. Subsequently for the second round, the statistical evaluation results and the questionnaires were sent to the experts who had participated in the first round. After the second round, the result was re-evaluated by taking into consideration the expert opinions that changed.

In the first round, 7016 experts were invited of whom 1636 responded to the survey. 550 experts responded by mail while the rest chose to respond over the web. Besides those experts that were explicitly invited, 687 experts participated so that the total number of respondents was 2323. The response rate was, thus, 23.3% among invited experts and 33.1% overall. This rate is considered to be in conformance with international experience (TÜBİTAK, 2004c, p. 69).

In the TÜBİTAK documentation there is no information available on the second round of the Delphi survey, in terms of the number of participants and the number who changed their opinions. An educated guess might be that there was a low percentage of participation in the second round and an insignificant rate of change of opinion. As there were many questions, responding to the Delphi survey might have been a tiresome task, causing experts fatigue and loss of interest for the second round.

The TÜBİTAK documentation concludes that the Turkish Delphi differs in some features from international examples. The first difference is that a specialized commission was not formed as it is usual for the implementation of a Delphi; but the sectoral panels took over this task. Second, the Internet was extensively used for gathering the responses. Third, experts were able to invite other experts to participate in the Delphi survey, so that the survey was open to broader participation. Fourth, the participants were able to respond not only to the questions in their own area of expertise but also to related questions of the other panels. Besides, they were able to initiate keyword searches and form individual questionnaires (TÜBİTAK, 2004c, p. 71).

4.4.2.2.3.4 The Delphi Survey Results

The result of the Delphi survey is extensively documented by TÜBİTAK in the Delphi Survey Results Report (TÜBİTAK, 2004b). In the Delphi Survey report, survey results with respect to the six groups of questions are presented in the form of radar graphs for the overall result per sub-variable and per each panel (socio-economic sector). Furthermore, detailed tables showing the percentage of answers on the overall survey result and per panel results are provided. All results are also presented with respect to the occupational area and occupation of the participants. The report also includes tables with the strongest and weakest Delphi statements with respect to the queried sub-variables. We will summarize some of these results here by focusing on those that are considered as important. It should be noted that the Delphi survey results need to be understood in relation to the specific Delphi statements. Since it is not possible to analyze each Delphi statement separately and it is beyond the context of this thesis to pass a judgment on the quality of the Delphi statements, it will be assumed that the statements as prepared by the expert panels, do in fact represent a sound and complete collection of expected S&T developments meaningful to Turkey. It is under the validity of this assumption only that the Delphi survey results can be supposed to have any significance. It should however be mentioned that some critiques were raised about the quality of the Delphi statements in the joint meeting of the panels held in February 2004, after the completion of the panels' work. This is the only indication about the quality of the Delphi statements and is documented in the minutes of this meeting (TÜBİTAK, 2004e). According to this document, the panel members criticized that the period allocated for the preparation of the Delphi statements was too short, some scientific mistakes were made in the process of preparation of the Delphi statements and many statements prepared by the panels were left out of the questionnaires.

For the sake of completeness, some sample Delphi statements that have appeared particularly strong or weak after the evaluation, are included in Appendix B.

The Level of Expertise and Participation Statistics

The first question of the Delphi survey was concerned with the level of expertise of the respondent. In all further evaluation of the Delphi results, the respondents who had assessed their expertise on the levels of 3 and 4 were considered as the 'experts group' and will be referred to as such in this thesis from now on. Reference will be made to 'all participants' in mentioning any results obtained by the votes of all participants. According to this supposition, 34.4 % of all participants belonged to the experts group. Table 4.2 shows the level of expertise per panel (or socio-economic sector) as well as the experts group percentages. As it can be observed from the table, the expert group has the highest percentage in the 'Information and Communication' (42%) and 'Textiles' (41.4%) sectors and smallest in the 'Transportation and Tourism' (28.5%) and 'Construction and Infrastructure' (28.1%) sectors.

Some interesting findings arise upon evaluation of the age and gender statistics and socio-economic profiles of the Delphi participants. For instance, 64% of all respondents were in the 25-44 years age group. Only 16.5 % of the participants in terms of the number of questions answered were female. The number of female participants was highest in the Environment and Sustainable Development Sector (31.9%). This result may be quite significant in demonstrating an example for the low level of female participation in public activity in Turkey.

Table 4.2: The Levels of Expertise of the Delphi Survey Participants

Level of Expertise (%) / Sector	No Expertise	Low Expertise	Adequate Expertise	High Expertise	Experts Group
All Sectors	**28,1**	**37,4**	**25,5**	**8,9**	**34,4**
Information and Communication	18,2	39,8	31,8	10,2	42,0
Environment and Sustainable Development	26,9	37,4	25,8	9,9	35,7
Energy and Natural Resources	28,5	37,1	26,6	7,8	34,4
Construction and Infrastructure	35,5	36,4	21,5	6,6	28,1
Chemicals	33,5	36,1	23,9	6,5	30,4
Machinery and Materials	28,3	41,0	24,4	6,2	30,6
Health and Pharmaceuticals	30,6	36,3	23,4	9,7	33,1
Defense, Aeronautics and Space	21,1	41,5	28,4	8,9	37,3
Agriculture and Food	30,7	34,8	23,4	11,0	34,4
Textiles	21,7	36,9	29,8	11,7	41,5
Transportation and Tourism	35,3	36,2	22,2	6,3	28,5

Source: TÜBİTAK (2004b, p. 11)

According to the occupation area, the majority of the experts (54.2%) who responded to the Delphi survey were from academia, followed by 24% from business circles and 21.8% from the public sector (excluding academia). With respect to occupation, 50% of all experts were faculty members, 27% directors or managers, and 11% research personnel (TÜBİTAK, 2004b, pp. 11-13).

The Present Situation

The question was aimed at determining the present state in Turkey with respect to the Delphi statement.

In the Delphi Survey report, the results are converted to fit in a scale between 0 and 3, whereby 0 to 0.49 represents ‘none’, 0.5 to 1.49 weak, 1.5 to 2.49 sufficient and 2.5 to 3 ‘strong’. 1.5 is the considered as the mid-point below which the responses are considered to be on the negative / none to weak site. Values above 1.5 are considered as positive / sufficient to strong (TÜBİTAK, 2004b, p. 16).

In order to gain a clearer overview, the results are compiled and shown in tabular form in Table 4.3.

It can be seen that, as expected, experts group’ opinion is generally more optimistic for all sub-variables in the present situation question and as will be seen in the whole survey result as well.

The general conclusion about each sub-variable is given in the second column of the table. The third and fourth columns show the socio-economic sectors with results above the general average and below the general average respectively.

Table 4.3: The Delphi Survey Results for the Present Situation Question

Sub-variable	**Result (All socio-economic sectors)**	**Sector's with most positive responses**	**Sector's with most negative responses**
Researcher Potential	Considered as slightly 'weak' (1.46) by all participants while the experts group opinion is situated in the 'sufficient' range (1.70).	**All Participants**: Information and Communication (1.48) The Environment and Sustainable Development (1.54) Agriculture and Food (1.63) **Experts Group** Health and Pharmaceuticals (1.80) The Environment and Sustainable Development (1.82) Agriculture and Food (1.84)	**All Participants** Energy and Natural Resources (1.38) Construction and Infrastructure (1.37) Machinery and Materials (1.30) **Experts Group** Information and Communication (1.64) Machinery and Materials (1.53)
R&D Infrastructure	There is a consensus that the R&D infrastructure is weak. All participants' votes average at 1.22 while the experts group opinion is situated at 1.41.	**All Participants**: Information and Communication (1,22) Chemicals (1,22) Transportation and Tourism (1.27) Agriculture and Food (1,37) **Experts Group** Agriculture and Food (1.52) Transportation and Tourism (1.56)	**All Participants** Machinery and Materials (1,08) Health and Pharmaceuticals(1.15) Defense, Aeronautics and Space (1.16) Energy and Natural Resources (1,16) **Experts Group** Machinery and Materials (1,27) The Environment and Sustainable Development (1.34) Information and Communication (1,36) Textiles(1,38) Defense, Aeronautics and Space (1.38)

Table 4.3 (continued): The Delphi Survey Results for the Present Situation Question

Sub-variable	**Result (All socio-economic sectors)**	**Sector's with most positive responses**	**Sector's with most negative responses**
Competency in Basic Science	The competency in related basic science is considered as positive by all participants as well as the expert group. The average for all participants is 1.65 and thus in the in the 'sufficient' range.	**All Participants**: Chemicals (1,65) Energy and Natural Resources (1.65) Information and Communication (1,66) Agriculture and Food (1,72) Textiles(1,73) The Environment and Sustainable Development (1.77) **Experts Group** Chemicals (1,96) Health and Pharmaceuticals(1.98) Energy and Natural Resources (1.98) The Environment and Sustainable Development (2.00)	**All Participants** Machinery and Materials (1,47) **Experts Group** Machinery and Materials (1,75) Information and Communication (1,82)
Innovation Capacity of Firms	There is a consensus that the innovation capacity of firms with respect to the Delphi statements is weak. All participants' votes average at 1.02 while the expert group opinion is at 1.16. This result acknowledges that firms are deemed to lack the innovation capacity in order to realize the Delphi statements.	**All Participants**: Construction and Infrastructure (1.06) Agriculture and Food (1.09) Information and Communication (1.09) Transportation and Tourism (1.14) Textiles (1.30) **Experts Group** Textiles (1.45) Transportation and Tourism (1.41)	**All Participants** Chemicals (0.84) **Experts Group** Chemicals (0.92) The Environment and Sustainable Development (1.05) Energy and Natural Resources (1.07) Machinery and Materials (1,07) Defense, Aeronautics and Space (1.13) Health and Pharmaceuticals(1.14)

Table 4.3 (continued): The Delphi Survey Results for the Present Situation Question

Sub-variable	**Result (All socio-economic sectors)**	**Sector's with most positive responses**	**Sector's with most negative responses**
Existence of Competitive Firms	With the exception of 'Textiles' all participants' (0.98) and the expert group (1.11) opinions acknowledge a serious weakness about the existence of competitive firms.	**All Participants**: Textiles (1.43) Information and Communication (1.01) Agriculture and Food (1.01) The Environment and Sustainable Development (1.08) **Experts Group** Textiles (1.67) Agriculture and Food (1.12) The Environment and Sustainable Development (1.31)	**All Participants** Transportation and Tourism (0.80) Chemicals (0.82) Construction and Infrastructure (0.88) Energy and Natural Resources (0.88) Defense, Aeronautics and Space (0.89) Health and Pharmaceuticals(0.92) Machinery and Materials (0.97) **Experts Group** Transportation and Tourism(0.86) Chemicals (0.92) Energy and Natural Resources (1.00) Construction and Infrastructure (1.02) Health and Pharmaceuticals (1.03) Information and Communication (1.09) Defense, Aeronautics and Space (1.10) Machinery and Materials (1.10)

Source: TÜBİTAK (2004b, pp. 16-18)

Beginning Competency

The aim of this question was to determine the beginning competency that should be acquired in order to realize the Delphi statement in question. The choices were 'basic research', 'applied/industrial research', 'pre-competition industrial development' and 'industrial development' among which one had to be chosen. Basic research is theoretical and experimental research done to acquire new knowledge not necessarily targeted at a specific implementation and use. Applied research on the other hand is research aimed at acquiring knowledge for a specific implementation or goal. Industrial research is attaining new knowledge to be used in the development of new or improvement of existing products processes or services. Pre-competition industrial development (including agriculture and services) involves work towards new or improved products, processes and services that is not expected to produce commercial value and use and therefore can be done jointly by competing firms. Industrial development involves activities intended for developing new or improved products, processes and services for commercial use (TÜBİTAK, 2004b, p. 41).

Similar to the 'present situation' assessment, the Delphi survey results for 'beginning competency' are converted to fit to a scale between 0 and 3, whereby 0 to 0.49 represents 'basic research', 0.5 to 1.49 'applied/industrial research', 1.5 to 2.49 'pre-competition industrial development' and 2.5 to 3 'industrial development'. In line with this approach the general result obtained including all socio-economic sectors was that the beginning competency was leveled at applied / industrial research, for all participants (1.0) as well as the expert group (1.1). The tendency towards applied / industrial research is highest in the 'Textiles' sector considering all participants and 'Transportation and Tourism' considering the expert group. The 'Information and Communication', 'Construction and Infrastructure' and 'Aeronautics, Defense and Space' sectors' experts also strongly leveled the beginning competency at applied / industrial research.

Whereas only 22.4% of the experts group voted in favor of basic research, it received 30% of all participants' votes and can thus be deemed as the second chosen beginning competency. The ‘Chemicals’ sector participants emphasized ‘basic research’ with 40% in their votes. The experts groups responses in the ‘Chemicals’ sector for basic research was only at 29%. Among all participants, the ‘Textiles’ and ‘Transportation and Tourism’ sector participants least emphasized basic research (25% and 24% respectively).

Pre-competition industrial development is considered as important by only 9.2 % of all participants. ‘Information and Communication’ (15.2%) and ‘Transportation and Tourism’ (16.5%) sectors’ experts had the most votes for this beginning competency.

Among all sectors, industrial development is deemed as most required by all participants and within the expert group of the ’Textiles’ and ‘Information and Communication’ sectors. The experts groups in both of these sectors voted for industrial development with about 16%. The lowest rate for ‘industrial development’ among the experts groups was in the ‘Agriculture and Food’ (6.8%) ‘Chemicals’ (7.2%) and the ‘Environment and Sustainable Development’ (8.9%) sectors (TÜBİTAK, 2004b, pp. 41-45).

Policy Tools

The policy tools questions’ purpose was to determine which of the policy measures among ‘R&D infrastructure support’, ‘R&D project support’, ‘start-up support’, ‘guided projects’ ‘human resources’ and ‘public procurement’ is considered as most effective in the realization of the Delphi statement. ‘R&D infrastructure suppor’ refers to grants to an organization for infrastructure investments such as the purchase of equipment while engaging in research that is not confined to a certain project. ‘R&D project support’ is the support provided in the form of grants, low interest credits or tax-exemptions to a specific R&D project. ‘Start-up support' is seed money or venture capital granted to aid the start-up and progress of technology development firms. ‘Guided projects’ are specific and well defined projects that are commissioned to consortiums or other organizations by R&D support organizations. ‘Human resources support’ involves policy measures that enable R&D personnel to be trained locally or abroad and for acquiring qualified local and foreign researchers. 'Public procurement support' involves policies that enforce the requirement of a certain minimum level of R&D and local content on products and services in public procurement, thereby helping to improve the R&D capabilities of the country.

The overall result for all participants and the expert group indicates that 'R&D project support' is the most favored policy tool with 31.5% of votes received followed by 'guided projects' with 20.2%. 15.8% of the experts group prefer 'R&D infrastructure support', 14.6% 'start-up support', 9.0% 'human resources support' and 6% 'public procurement' measures (TÜBİTAK 2004b, pp. 52-53).

The survey result with respect to the policy tools question is given in Table 4.4.

Table 4.4: The Delphi Survey Results for the Policy Tools Question

Sub-variable	**Result (All socio-economic sectors)**	**Sector's with highest rates**	**Sector's with lowest rates**
R&D Project Support	Most favored policy tool by all sectors with 31.5%	**All Participants**: Machinery and Materials (33.9%) Chemicals (33.8%) **Experts Group** Machinery and Materials (33.6%) Textiles (33.2%) Chemicals (33 %) Defense, Aeronautics and Space (33%) Agriculture and Food (32.8%)	**All Participants** Construction and Infrastructure (%29) Information and Communication (%28.9) Health and Pharmaceuticals (%28.3) **Experts Group** Transportation and Tourism (%28.2) Information and Communication (%27.8) Construction and Infrastructure (%26.9)
R&D Infrastructure Support	Overall, R&D infrastructure support is the 3rd most preferred policy tool for all participants (18.1%) and the expert group (15.8%). There is great difference in expert group versus all participants' opinion in that the experts are lesser inclined to support this tool, except for textiles.	**All Participants**: Machinery and Materials (20.6%) Chemicals (19%) Energy and Natural Resources (19 %) **Experts Group** Textiles (18%) Machinery and Materials (17.8%) Agriculture and Food (16.9%) Information and Communication (%16.6)	**All Participants** Transportation and Tourism (16.1%) The Environment and Sustainable Development (16.9%) Agriculture and Food (16.9%) **Experts Group** Defense, Aeronautics and Space (14.6%) Construction and Infrastructure (13.8%) Transportation and Tourism (13.1%)

Table 4.4 (continued): The Delphi Survey Results for the Policy Tools Question

Sub-variable	Result (All socio-economic sectors)	Sector's with highest rates	Sector's with lowest rates
Start-up Support	Overall, start-up support is the 4th most preferred policy tool for all participants (14.7%) and the expert group (14.6%). There is not much difference in expert group versus all participants' opinion.	**All Participants**: Textiles (18.2%) Transportation and Tourism (15.9%) Energy and Natural Resources (15.6%) **Experts Group** Textiles (18.6%) Transportation and Tourism (18.2%) Health and Pharmaceuticals (16.5%)	**All Participants** Agriculture and Food (14.1%) Chemicals (13.6%) Defense, Aeronautics and Space (11.3%) **Experts Group** The Environment and Sustainable Development (13.9%) Agriculture and Food (13%) Defense, Aeronautics and Space (9.2%)
Guided Projects	Overall, guided projects is the second preferred policy tool by all participants at 20.2% and by the expert group at 23.1%.	**All Participants** Environment and Sustainable Development (23.7%) Defense, Aeronautics and Space (21.9%) Construction and Infrastructure (21.6%) **Experts Group** Construction and Infrastructure (30.1%) Defense, Aeronautics and Space (26.7%) Energy and Natural Resources (26.6%)	**All Participants** Machinery and Materials (19%) Health and Pharmaceuticals (17.5%) Textiles (15.7%) **Experts Group** Machinery and Materials (21 %) Health and Pharmaceuticals (20%) Textiles (16.4%)
Human Resources Support	Human resources support is a preferred policy tool by all participants only at 10.1% and by the expert group at 9 %.	**All Participants** Health and Pharmaceuticals (13.5%) Textiles (11.6%) Agriculture and Food (10.7%) **Experts Group** Health and Pharmaceuticals (12.7%) Textiles (11.8%) Machinery and Materials (10%)	**All Participants** Construction and Infrastructure (8.4%) Transportation and Tourism (7.9%) Energy and Natural Resources (7.6%) **Experts Group** Defense, Aeronautics and Space Industry (6.5%) The Environment and Sustainable Development (6.5%) Construction and Infrastructure (6.3%)

Table 4.4 (continued): The Delphi Survey Results for the Policy Tools Question

Sub-variable	Result (All socio-economic sectors)	Sector's with highest rates	Sector's with lowest rates
Public Procurement	Least preferred policy tool by the expert group (6%) as well as all participants (5.5%). Significant emphasis by the information and communication and Defense, Aeronautics and Space sectors in comparison to other sectors.	**All Participants** Information and Communication (9.1%) Defense, Aeronautics and Space (8.3%) Transportation and Tourism (7.8%) **Experts Group** Information and Communication (10.5%) Defense, Aeronautics and Space (10.1%) Construction and Infrastructure (8.6%)	**All Participants** Textiles (1.6%) Machinery and Materials (2.6%) Chemicals (3.2%) **Experts Group** Textiles (1.9%) Machinery and Materials (2.8%) Chemicals (3.3%)

Source: TÜBİTAK (2004b, pp. 53-61)

Realization Time

The question aimed to determine when the Delphi statement could be realized. 5 year periods among 2003-2007, 2008-2012, 2013-2017, 2018-2022 and '2023 and afterwards, and 'never' were the options to choose from.

Like with the other questions, the expert group responses were more optimistic and predicted faster realization. The central tendency as a result to this question is that in case the recommended strategies are implemented, then the most likely realization time is seen as the 2008-2012 period. This opinion is shared by the experts groups (38.9%) as well as all participants (38.6%). The evaluation with respect to the socio-economic sectors reveals that for the experts groups of the 'Environment and Sustainable Development', 'Construction and Infrastructure' and 'Textiles' sectors, there is consensus that the realization will occur in the first five year period of 2003-2007, whereas for all other sectors consensus was reached on the second five year period of 2008-2012 (TÜBİTAK, 2004b, pp. 46-48).

The 'realization time' question is highly hypothetical since the responses depend on the condition that certain recommended strategies are implemented, which were unclear at the time the question was answered. Nevertheless, it provides an indication of what is anticipated by the participants as likely to occur, if strategies are implemented, and conditions are favorable.

Contribution to Turkey

The purpose of this question was to determine the contribution to Turkey in terms of the strategic technology criteria comprising of ‘competitive strength’, ‘science, technology and innovation capacity’, ‘environment friendliness and ‘energy efficiency’, ‘national added value’ and ‘quality of life’, as explained in Section 4.4.2.2.3.2.

In the evaluation given in the Delphi Survey report, the results were again converted to fit in a scale between 0 and 3, whereby 0 to 0.49 represents ‘no effect’, 0.5 to 1.49 ‘small effect’, 1.5 to 2.49 ‘effective’ and 2.5 to 3 ‘very effective’. 1.5 is the considered as the mid-point below which the responses are considered to be on the negative / no effect to small effect site. Values above 1.5 are considered as positive / effective to very effective (TÜBİTAK, 2004b, pp. 67-68).

The overall evaluation shows that all participants and the experts group are in consensus about the positive effect that the predicted S&T developments in the Delphi statements are likely to have on Turkey. The expert group opinion is more optimistic than the average of all participants. The survey result with respect to the contribution to Turkey question is given in Table 4.5.

Table 4.5: The Delphi Survey Results for the Contribution to Turkey Question

Sub-variable	Result (All socio-economic sectors)	Sectors with most positive responses	Sectors with most negative responses
Competitive Strength	Experts' group average is 2. There is much difference in experts' group opinion versus all participants.	**All Participants** Defense, Aeronautics and Space (2.16) Energy and Natural resources (2.09) Textiles (2.08) Agriculture and Food (2.07) **Experts Group** Textiles (2.21) Agriculture and Food (2.19) Machinery and Material (2.14)	**All Participants** Transportation and Tourism (1.87) Chemicals (1.87) Environment and Sustainable Development (1.86) Construction and Infrastructure (1.80) **Experts Group** Construction and Infrastructure (1.93) Energy and Natural Resources (1.85) Environment and Sustainable Development (1.74)
Science, Technology and Innovation Capacity	Highest contribution to Turkey is anticipated to be by technologies that incorporate science, technology and innovation capability. Expert group average for this sub-variable is at 2.19	**All Participants** Defense, Aeronautics and space (2.26) Agriculture and Food Environment and Sustainable Development (2.08) **Experts Group** Defense, Aeronautics and Space (2.32) Energy and Natural Resources (2.23) Agriculture and Food (2.21) Health and Pharmaceuticals (2.20)	**All Participants** Transportation and tourism (1.97) Energy and Natural Resources (2.05) Chemicals (2.03) **Experts Group** Information and Communication (2.13) Environment and Sustainable Development (2.12) Transportation and Tourism (2.09)

Table 4.5 (continued): The Delphi Survey Results for the Contribution to Turkey Question

Sub-variable	**Result (All socio-economic sectors)**	**Sectors with most positive responses**	**Sectors with most negative responses**
Environment Friendliness and Energy Efficiency	The environment friendliness and energy efficiency of a technology is considered at least effective by the experts group among the other sub-variables. Experts group average is 1.92	**All Participants** Agriculture and Food (2.29) Environment and Sustainable Development (2.13) Energy and Natural Resources (2.12) Construction and Iinfrastructure (2.12) Defense, Aeronautics and Space (2.10) **Experts Group** Environment and Sustainable Development (2.67) Energy and Natural Resources (2.39) Agriculture and Food (2.21) Transportation and Tourism (2.19) Construction and Iinfrastructure (2.17) Chemicals (2.04) Machinery and Materials (1.94)	**All Participants** Transportation and Tourism (2.06) Health and Pharmaceuticals (2.04) Textiles (2.03) Information and Communication (1.99) Chemicals (1.96) Machinery and Materials (1.94) **Experts Group** Health and Pharmaceuticals (1.49) Defense, Aeronautics and Space (1.41) Information and Communication (1.35)
National Added Value	The national added value of a technology is the second most effective sub-variable that bears a positive effect on Turkey. Expert group average is 2.17. Strongly emphasized by Agriculture and Food sector.	**All Participants** Agriculture and food (2.29) Energy and Natural Resources (2.12) Environment and Sustainable Development (2.13) **Experts Group** Agriculture and Food (2.36) Energy and Natural Resources (2.25) Defense, Aeronautics and Space (2.23) Health and Pharmaceuticals (2.22)	**All Participants** Information and Communication (1.99) Chemicals (1.96) Machinery and Materials (1.94) **Experts Group** Textiles (2.07) Information and Communication (2.06) Chemicals (2.03)

Table 4.5 (continued): The Delphi Survey Results for the Contribution to Turkey Question

Sub-variable	Result (All socio-economic sectors)	Sectors with most positive responses	Sectors with most negative responses
Quality of Life	The contribution to the quality of life in Turkey is the third sub-variable at 2.13 expert's group average. Highest contribution is envisaged by the Environment and Sustainable Development sector.	**All Participants** Environment and Sustainable Development (2.40) **Experts Group** Environment and Sustainable Development (2.46) Transportation and Tourism (2.41) Health and Pharmaceuticals (2.41) Construction and Infrastructure (2.39) Information and Communication (2.23) Energy and Natural Resources (2.21) Agriculture and Food (2.15)	**All Participants** Machinery and materials (1.99) Defense, Aeronautics and Space (1.97) Textiles (1.76) **Experts Group** Machinery and Materials (1.94) Defense, Aeronautics and Space (1.89) Textiles (1.71)

Source: TÜBİTAK (2004b, pp. 67-76)

Importance and Feasibility Indices

As explained in Section 4.4.2.2.3.2, the steering committee had determined the strategic technology criteria via a participative process. The steering committee also assigned a relative weight to each criterion. In order to finally decide which technology was most important, it was necessary to create an index based upon these criteria and their weight. The formula of the importance index is given below. The weight of each criterion is given in Table 4.6 (TÜBİTAK, 2004b, p. 82):

$$i = (100/3n) \sum_{i=1}^{n} \sum_{j=1}^{5} w_j E_{ij}$$

Table 4.6: The Weights of the Strategic Technology Criteria

Criterion	**Weight**
Competitive Strength	28%
Science, Technology and Innovation Capacity	26%
Environment Friendliness And Energy Efficiency	16%
National Added Value	15%
Quality of Life	15%

Source: TÜBİTAK (2004b, p. 82)

In the formula of the importance index, E_{ij}, is the response of participant *i* (*i* = 1 … n) to criterion *j* and w_j the weight assigned to criterion *j* as given in Table 4.6. The value of *E* is 0 for a ‘no effect’, 1 for a ‘small effect’, 2 for an ‘effective’ and 3 for a ‘very effective’ response given by the participant to the sub-variable in the ‘Contribution to Turkey’ question in the Delphi survey (TÜBİTAK, 2004f, pp. 71-72).

When calculated according to this formula, the value of the importance index of all Delphi statements yields a result in the 40.32 to 80.42 range for all participants (TÜBİTAK 2004b, p. 82). The five Delphi statements with the highest importance indices for all participants and the experts group are given in Appendix B. The TÜBİTAK documentation lists the statements from 'Agriculture and Food' separately as there were many statements with high importance indexes, from the 'Agriculture and Food' sector. The list with the 20 Delphi statements that received the highest score for the importance index for the remaining sectors includes 5 statements from the 'Textiles' sector, 4 statements from 'Transportation and Tourism' sector, 3 statements from the 'Environment and Sustainable Development' sector, 2 statements from the 'Machinery and Materials' sector and 1 statement each from the 'Information and Communication', 'Defense, Aeronautics and Space' and 'Construction and Infrastructure' sectors. 3 Delphi statements are mixed statements that appear in the questionnaires of more than one sector.

When considering only the experts group, the importance index values obtained range from 41.08 to 84.22. This is a slightly more optimistic result against all participants. In the list with the first twenty Delphi statements of the experts group there are 7 statements that are related to more than one sector (TÜBİTAK, 2004b, pp. 82-86).

In order to determine whether a technology is strategic or not, it is also important to consider its feasibility. Some technologies may be easy to implement but can be of a lesser importance while some technologies may be important but also very difficult to implement in other words, less feasible. Therefore, the project office created a feasibility index that represents the feasibility of a technology and depends on the present situation and the beginning competency sub-variables. The reasoning is that the difficulty of the statement depends on the present situation with respect to that technology and the beginning competency that needs to be acquired. The formula used to calculate the feasibility index, MDY_i, is given below:

$$MDYi = (100/3n) \sum_{i=1}^{n} \sum_{j=1}^{5} w_{ij} M_{ij}$$

The weights of the present situation versus beginning competency sub-variables are given in Table 4.7. The formula works similar to the importance index formula except that now M_{ij} is the assessment of participant i of present situation j, and w_{ij} represents the weight for this participant for sub-variable j. M takes the value of 0 for a 'none', 1 for a 'weak', 2 for a 'sufficient' and 3 for a 'strong' response by the participant to the present situation sub-variable (TÜBİTAK, 2004f, p. 72).

Table 4.7: The Weights of the Present Situation versus Beginning Competency Sub-Variables

	Weights (w_{ij})				
Present Situation / **Beginning Competency**	Researcher Potential	R&D Infra-structure	Competency in Basic Science	Innovation Capacity of Firms	Competitive Firms
Basic Research	25%	25%	25%	15%	10%
Applied / Industrial Research	25%	20%	20%	20%	15%
Pre-Competition Industrial Development	20%	20%	15%	20%	25%
Industrial Development	20%	15%	10%	30%	25%

Source: TÜBİTAK (2004b, p. 87)

When calculated by this formula, the feasibility index for the Delphi statements according to all participants' responses covers the range of 22.39 to 63.38. The list of the top 20 Delphi statements with the highest feasibility index includes 9 statements from 'Textiles', 5 statements from 'Information and Communication' 2 statements from 'Health and Pharmaceuticals', 1 each statement from 'Transportation and Tourism' and the 'Environment and Sustainable Development'. The remaining 2 statements are mixed ones. Again, the 'Agriculture and Food' sector's statements with highest feasibility indexes are treated separately and are not included in this list.

The experts group is once again more optimistic than all participants with feasibility indices ranging from 21.79 to 68.60. In the experts' top 20 list are 6 statements from the 'Textiles' sector, 3 statements from 'Transportation and Tourism' 2 each statements from 'Information and Communication' and 'Health and Pharmaceuticals'. Five combined statements from 'Construction and Infrastructure' and 'Transportation and Tourism' as well 2 combined statements from 'Information and Communication' and 'Health and Pharmaceuticals' are also in this list (TÜBİTAK, 2004b, pp. 87-91). The list of the five Delphi statements with the highest feasibility indices is given in Appendix B.

The TÜBİTAK documentation also includes an analysis that involves a combined index obtained from the multiplication of the feasibility and importance indexes. This is deemed to provide an account of the Delphi statement that entails both its importance as well as its feasibility.

It is a striking result that the 'Agriculture and Food', 'Textiles' and 'Transportation and Tourism' sectors have so many statements with high importance and feasibility indices. These sectors are not precisely those that are appreciated for their high technology content. So much so, it was necessary to prepare a separate list for the 'Agriculture and Food' sectors most important and feasible Delphi statements, as otherwise the agriculture and food sector would have strongly dominated. Notwithstanding that this result may have to do with the higher number of Delphi statements for these sectors or more optimism or decisiveness on part of the participants in these sectors in comparison to others, the Delphi survey result should acknowledge that for Turkey it will not be wise to not attend to the needs of these sectors in the context of S&T policy.

4.4.2.2.4 Phase 4 - Road Maps and Policy Recommendations

After the diffusion / consultation phase and the Delphi survey, the panels revised their preliminary reports. In Section 4.4.2.2.3.2 we had explained the process of how the ‘strategic technology criteria’ had been derived, as these were also used as a question in the Delphi Survey. Although the TÜBİTAK documentation states that the panels used the ‘strategic technology criteria’, the explanations given with respect to the working methods of each panel suggest that the panels freely choose other criteria or voting in order to prioritize the technological activity topics (TÜBİTAK, 2004c, pp. 32-64). Thereafter, the panels determined the underpinning technologies to implement the technological activity topics, the problems related to acquiring these underpinning technologies and the necessary science, technology and innovation policies that would facilitate this development. Furthermore, the panels also reflected on and formulated suggestions with respect to legal, financial, institutional and administrative policies.

The next step involved the preparation of roadmaps showing the timeline for the necessary steps and developments, the capabilities to be acquired and the policies to be implemented for each technological activity topic. This effort was supported by a 2 days workshop held in July 2003 to which members of all panels participated. In the preparation of the roadmaps, the results of the Delphi survey were used. The roadmap forms prepared for each technological activity topic included provision to indicate the related Delphi statements queried, the present situation, the beginning competencies and policy tools in the same format as the Delphi survey questions and other suggested policy tools.

The final reports of the panels incorporating the results of all these efforts were issued in July 2003, posted on the TÜBİTAK website and distributed to all related organizations.

4.4.2.2.5 The Synthesis of the Foresight Results

After the finalization of the panel reports, it was necessary to evaluate and combine the findings of the panels; in order to gain an overview and be able to develop an S&T strategy later on. This effort was undertaken by the project office and is documented in part 3 of TÜBİTAK's 'Synthesis Report (TÜBİTAK, 2004d). (Part 1 details the methodology used and the process, part 2 includes the panel reports in summary form).

The synthesis report does not provide any indication as to how the procedure of synthesizing the panel findings was conducted, but merely lists the results of the effort.

4.4.2.2.5.1 The SWOT Analysis

Table 4.8 shows the result of the SWOT analysis for Turkey, compiled from the different panels' inputs. The list of strengths, weaknesses, opportunities and threats also includes many sub-items that are not listed in table 4.8.

The SWOT analysis reveals the eminence of human resources issues. Several aspects of the human resources issue are considered as strengths, weaknesses opportunities and threats. For instance, while the existence of a young and dynamic population that is open and can easily adjust to advanced new technologies is seen as a strength, high population increase, lack of proper and sufficient education for this young population constitutes a major weakness. By consequence, human resources management appears as one of the most important strategic variables for Turkey in acquiring the desired level of competency in science and technology. It is necessary to develop policies that remedy the weaknesses of Turkey's human resources and capitalize on the opportunities that are given by the young population through proper education and employment policies. Otherwise, not receiving a proper education and suffering from unemployment, the same population would constitute a major threat.

Table 4.8: SWOT Analysis for Turkey

Strengths
Human resources
Geographical situation and natural resources
The science technology and innovation infrastructure
The competitive strength of the industry
Weaknesses
Human resources
Political, administrative and bureaucratic obstacles
Weaknesses pertaining to the structure, infrastructure and development of the industry
Lack of coordination and cooperation
Cultural factors
Opportunities
Human resources
Opportunities that are created through globalization
Technological opportunities
Threats
Population increase and brain drain
Threats that result from globalization
Lack of ability to adjust to the rapid development of S&T

Source: TÜBİTAK (2004d, pp. 3-8)

Another fact that stands out as a result of the SWOT analysis is that public procurement and defense procurement is a strategic variable that must be considered in S&T policy. Turkey's global position obligates heavy defense, aeronautics and space industry investments and the development of associated products and services with advanced technology content. This necessity is considered as an opportunity to develop the S&T infrastructure. Furthermore, the expected spill over of the technologies developed in this area to the private sector is regarded as a driving force and an opportunity itself under the technological opportunities heading. Under the strengths / science, technology and innovation infrastructure heading, the opportunities of large scale national projects such as defense procurement programs, national research infrastructure programs and municipality infrastructure programs are listed as a major strength, while under the weaknesses /

political administrative and bureaucratic obstacles heading, it is stated that the government does not adequately support the science and technology development efforts with due public procurement policies. Thus, the conclusion is that public procurement is a very effective way in increasing the S&T competency of the country, provided that policies are put in place to serve that purpose (TÜBİTAK, 2004d, pp. 7-8). This notion is somewhat in contradiction with the Delphi Survey result, where 'public procurement' was the least preferred policy tool among the other suggested policy tools. However, in the Delphi survey, public procurement was most favored by defense, aeronautics and space, information and communication and construction and infrastructure sectors, which is comprehensible considering the larger scale of projects and investment required in these sectors.

According to the SWOT Analysis, the inclination of the industry to buy and use systems and technologies from abroad instead of basing production on in-house or local R&D efforts, leads to deficiency in developing new technologies and is considered as a major weakness on part of the Turkish industry. Exceptionally, the automotive and its byproduct industries, the household appliances industry and consumer electronics and machine manufacturing industries developed over the past years a tendency to engage in R&D based production and technology development, targeting to become design and technology development centers on global scale. This was facilitated by the developed countries' practice of shifting the production lines for consumer goods to peripheral economies and the opportunity to transfer knowledge and technology from global producers active in Turkey. Furthermore, the R&D support measures that were enacted in the recent past positively contributed to this development. It is anticipated that new opportunities for the Turkish industry in global markets will develop, if this tendency continues and if the R&D support programs for the private sector are further developed and diversified. Otherwise the Turkish industry faces the threat to even loose its current competitive advantage in the global markets (TÜBİTAK, 2004d, pp. 7-8).

4.4.2.2.5.2 The Vision

The vision for the 100th anniversary of the Republic, as formulated in the synthesis report is a country that,

- Strives to maintain a just and lasting piece in its region and in the world,
- Has a democratic and just legal system,
- Citizens participate in decisions regarding their countries' future,
- Citizens' needs in health, education and culture are under the guaranty of the government,
- Has a just income distribution and furthers sustainable development in a healthy and livable environment,
- Has developed communication, organization and cooperation skills,
- Is competent in science, technology and innovation, is productive, and can increase the net added value by relying on its own intellectual strength,
- Is populated by creative and entrepreneurial citizens with high self esteem, who have respect of nature and of each-other (TÜBİTAK, 2004d, p. 9).

The synthesis report then lists the 'elements of this vision' with respect to the socio-economic sectors for almost two pages (TÜBİTAK, 2004d, pp. 9-10). It is not obvious whether the vision as stated above was just composed by the project office or compiled and synthesized from the elements of the visions of the panels. That it should have been done different, was brought up as due critique in the panels' joint meeting held in February 2004, during the time when the synthesis report was in preparation. In the minutes of the meeting under 'criticism about the project management' topic, it is stated that a vision for Turkey should have been defined at the very beginning of the technology foresight project, before the commencement of panel work. It appears that during the work of the panels, the lack of an all encompassing vision to guide the efforts of the panels was severely experienced. This problem might as well have been avoided, if a scenarios approach had been employed. The panels could than have aligned their predictions to those alternative scenarios. But, neither being the case, the panels had difficulty in forming a vision for their own sector. This difficulty is acknowledged, in the machinery and material panels' description of working methods (TÜBİTAK, 2004c, p. 48), where it is stated that the national vision should have been formed, by a participative process in which various segments of society were represented. Since this was not done, the 'Machinery and Materials' panel in cooperation with the textiles panel organized a workshop and undertook the task oft forming a national vision. This endeavor was referred to as 'process A' (TÜBİTAK, 2004c, p. 48). Further details about 'process A' and its effect on the overall foresight project are not documented. However, the national vision as determined by the 'Machinery and Materials' panel and given in the panels' final report has a very similar wording to the national vision stated in earlier versions of the synthesis document part 3.

4.4.2.2.5.3 Socio-Economic Goals, Technological Activity Topics and Technology Areas

In accordance with the framework drawn for the foresight exercise, all panels had aligned their work in following the - vision- socio-economic goals- technological activity topics – technology areas- thread. The synthesis becomes somewhat incomprehensive and complicated when the socio-economic goals that support the vision are introduced. Four groups of socio-economic goals, deducted from and grouped on the basis of the work of the panels are defined:

- Goals regarding the achievement of competitive advantage in industrial production
- Goals regarding the improvement of the quality of life
- Sustainable development goals

- Goals regarding the strengthening of the technological infrastructure and the transition to a knowledge society (TÜBİTAK, 2004d, p. 11).

In the synthesis report, these groups of socio-economic goals are further elaborated and include sub-items from the panels' work, so as to cover 5 pages (TÜBİTAK, 2004d, pp. 11-15). We will omit any further specifics related to the socio-economic goals and their explanations. However, the listing of the first sub-categories of socio-economic goals and the number of further sub-categories is given in the first column of Table 4.9, which is a comprehensive compilation of the foresight result in terms of technological priorities. The second column of the same table includes the technological activity topics that were defined by the panels and grouped under the socio-economic goals. A total of 94 technological activity topics had been defined by the panels (TÜBİTAK, 2004d, p. 17). The grouping in the synthesis however yielded 66 technological activity topics which are listed in Table 4.9. How this reduction came about is unclear, but may have been the result of the grouping of similar items. (In Annex 2 of the strategy document that will be covered in Section 4.5.1, the list is further reduced by 1 item yielding 65 technological activity topics; Within this document, items 3 and 4 under the sustainable development – sustainable environment goals, are merged into 1 item).

The predictions of the panels with respect to each technological activity topic are explained in the second part of the synthesis report that covers the panel reports in summary form. The synthesis report includes brief explanations with respect to each technological activity topic (TÜBİTAK, 2004d, pp. 17-35).

Table 4.9: Socio-Economic Goals, Technological Activity Topics and Strategic Technology Areas

Socio-economic Goal	Technological Activity Topics	Related Strategic Technologies*
Socio-economic Goal - The Achievement of Competitive Advantage in Industrial Production		
Acquiring the ability to develop **Flexible Production – Flexible Automation Processes and Technologies** (3 goals under this heading)	**1.** Acquiring advanced sensor technologies Developing pneumatic actuators with positioning and repeating accuracy of less than +/- 0.5 mm's. Acquiring technologies that increase man-machine interaction and system usage efficiency. Acquiring unmanned systems and robotics technologies. Design and production of smart machines (industrial robots, micro-machines, microelectronics production equipment, self-guided machines). **2.** Developing flexible and process-intensive production processes that facilitate rapid product change-over in the chemicals industry. **3.** Providing data and knowledge exchange in electronic format in the textiles sector (on-line trading). **4.** Enabling machine adjustments without human intervention in textiles sector; Computer-aided weaving design and production in textiles; Individual service and techno-tailoring in garments industry. **5.** Acquiring competency in the production of capital equipment and systems for mass-production that enable flexibility and rapid adjustment to demand changes	**1.** ICT, EE, MAT, MEC, NANO, DES, PP **2.** ICT, MAT, MEC, PP **3.** ICT **4.** ICT, MAT, MEC, PP **5.** ICT, EE, MAT, MEC, NANO, DES, PP

Table 4.9 (Continued): Socio-Economic Goals, Technological Activity Topics and Strategic Technology Areas

Socio-economic Goal	**Technological Activity Topics**	**Related Strategic Technologies***
Developing products with high added value and knowledge content and **Becoming a Global Design and Production Center for Consumer Commodities.** (5 goals under this heading)	**1.** Developing automotive components with enhanced security and comfort features and light-weight motorized vehicle chassis with enhanced security. **2.** Hybrid vehicle production. **3.** Enhancing household appliances with new distinctive features and persuing their production with environmental awareness. **4.** Production of strategic components (MEMS and digital integrated circuits) for quality added value in communication and information technologies **5.** Design and production of new generation equipment in consumer electronics. **6.** Developing new chemical synthesis methods that employ alternative raw materials and/or alternative processes. **7.** Developing multi feature / multi purpose smart textiles. **8.** Reaching a level of competence compatible with the countries' needs in general services machines and systems (construction machines, building mechanization and automation systems, harbor and airport equipment, etc.)	**1.** ICT, MAT, MEC, NANO, DES, PP **2.** ICT, EE, MAT, MEC, NANO, DES, PP **3.** ICT, EE, MAT, MEC, NANO, DES, PP **4**. ICT, MEC, DES **5.** ICT, MEC, DES **6.** ICT, BIO, MAT, PP **7**. MEC, NANO, PP **8.** ICT, EE, MAT, MEC, NANO, DES, PP
Acquiring '**Clean Production**' capability (1 goal under this heading)	**1.** Development and diffusion of highly efficient clean production processes, systems and technologies **2.** Usage of energy saving technologies in industrial processes. **3.** Usage of energy saving and environment friendly technologies in textiles finishing.	**1.** ICT, BIO, EE, MAT, NANO, PP **2.** EE, PP **3.** EE, MAT, PP
Competitiveness in **Agricultural Production** (14 goals under this heading)	**1.** Development of instruments, tools, equipment and production systems in agriculture, forestry, food and sea products. **2**. Production of seeds, seedlings, saplings and broods. **3.** Development of new genotypes for vegetal and animal production by combining classical methods with biotechnology. **4.** Activating combat against disease and pest in agriculture with prevention, control and treatment techniques. **5.** Development of food processing methods and increasing the variety of processed food. **6.** Development and diffusion of remote sensing and early warning systems, information systems and software in agriculture and forestry.	**1.** MAT, PP **2.** BIO, PP **3.** BIO **4.** BIO, PP **5.** ICT, BIO, MAT, MEC, PP **6.** ICT

Table 4.9 (Continued): Socio-Economic Goals, Technological Activity Topics and Strategic Technology Areas

Socio-economic Goal	Technological Activity Topics	Related Strategic Technologies*
Acquiring the ability to develop **Space and Defense Technologies** (3 goals under this heading)	**1.** Acquiring satellite and space vehicle technologies. **2.** Acquiring critical weapons, ammunition and defense systems and technologies. **3.** Development and production of NBC (Nuclear, biological, chemical) sensor systems.	**1.** ICT, MAT, DES, **2.** EE, MAT, MEC, NANO, DES, PP **3.** ICT, BIO, EE, MAT, MEC, PP
Acquiring the ability to develop **Materials Technologies** (2 goals under this heading)	**1.** Development of new products by using traditional materials (High quality steel, multi-functional smart glass, composite fiber cement, etc.) **2.** Development of high-performance, ultra-light and high-resistant organic, inorganic and composite materials and their production methods. **3.** Development of hydrogen storing materials. **4.** Gaining competency in electro-optical materials.	**1.** MAT, NANO, PP **2.** BIO, MAT, NANO, DES, PP **3**. EE, MAT, NANO **4.** ICT, MAT, MEC, NANO, PP
Socio-economic Goal - the Improvement of the Quality of Life		
Food Safety and Reliability (2 goals under this heading)	**1.** Ensuring food safety and reliability.	**1.** ICT, BIO, PP

Table 4.9 (Continued): Socio-Economic Goals, Technological Activity Topics and Strategic Technology Areas

Socio-economic Goal	Technological Activity Topics	Related Strategic Technologies*
Health and Life Sciences (11 goals under this heading)	**1.** Development and production of recombinant molecules in treatment and prevention.	**1.** ICT, BIO, DES
	2. Development of controlled drug release, delivery and targeting technologies.	**2.** ICT, BIO, MEC, NANO, DES
	3. Discovering new active molecules by using rational pharmaceuticals design methods.	**3.** ICT, BIO, MEC, DES
	4. Treatment of degenerative diseases with cell and gene treatment methods.	**4.** ICT, BIO, NANO, DES
	5. Development of diagnostic and therapeutic kits and medical devices.	**5.** ICT, BIO, MEC, DES
	6. Development and production of minimally invasive diagnosis and treatment methods.	**6.** ICT, MEC, NANO, PP
	7. Development and production of multi-functional medical imaging equipment and systems.	**7.** ICT, EE, MAT, MEC, NANO, PP
	8. Development and production of diagnostic equipment that can produce molecular biology and genetics supply materials such as nucleic acids, proteins and antibodies.	**8.** ICT, EE, MAT, MEC, NANO, PP
	9. Development and production of smart prosthesis and sense organs.	**9**. ICT, EE, MAT, MEC, DES, PP
	10. Provision of remote health services; Development and diffusion of remote patient monitoring equipment and systems.	**10**. ICT, EE, MEC, DES
Healthy and Contemporary Urbanization and Infrastructure (5 goals under this heading)	**1.** Construction of high quality buildings; Strengthening and rehabilitation of existing buildings; Production of earthquake safe buildings and infrastructure; Design and production of specially engineered buildings.	**1.** ICT, EE, MAT, PP
	2. Reducing the energy requirement of buildings and supply of this energy from renewable sources.	**2.** EE, MAT, PP

Table 4.9 (Continued): Socio-Economic Goals, Technological Activity Topics and Strategic Technology Areas

Socio-economic Goal	**Technological Activity Topics**	**Related Strategic Technologies***
Transportation (4 goals under this heading)	**1.** Development of rail-systems software and production of rails, wheels and railway cars. **2.** Development of smart vehicles and smart road systems for motorway transportation. **3.** Development of systems that increase the speed and security of combined freight transportation. **4.** Development and diffusion of fire and security systems for the transportation and tourism superstructure	**1.** ICT, MAT, PP **2.** ICT, MAT, MEC, DES **3.** ICT **4.** ICT, MEC
Socio-economic Goal - Sustainable Development		
Human Resources (3 goals under this heading)	(No technological activity topics defined for this goal)	
Energy (7 goals under this heading)	**1.** Production of electrical energy from brown coal (lignite). **2.** Production of electrical energy from renewable (hydraulic, wind, solar) energy sources. **3.** Nuclear energy production. **4.** Development of hydrogen (an alternative energy source) production methods from sustainable sources and hydrogen burning methods. **5.** Production of fuel cells for usage in power plants, transport vehicles and electronic equipment and alternative fuels and compatible vehicles technologies. **6.** Power systems and energy storage control.	**1.** EE, **2.** EE **3.** EE **4.** EE, MAT, NANO **5.** EE, MAT, NANO, PP **6.** EE, MAT
Sustainable Environment (5 goals under this heading)	**1.** Development of technologies related to air quality and climate change control. **2.** Development of sustainable usage of water sources technologies. **3.** Development of sea and soil pollution prevention technologies. **4.** Development and diffusion of solid waste reuse and hazardous waste disposal technologies.	**1.** ICT, BIO, EE, DES, PP **2.** ICT, BIO, EE, MEC, DES, PP **3.** ICT, BIO, EE, DES, PP **4.** ICT, BIO, EE, DES, PP

Table 4.9 (Continued): Socio-Economic Goals, Technological Activity Topics and Strategic Technology Areas

Socio-economic Goal	**Technological Activity Topics**	**Related Strategic Technologies***
Profiting from **Natural Resources** (8 goals under this heading)	**1.** Characterization and saving of gene sources and development of technologies for the preservation of the biological variety. **2.** Using and enhancing vegetal and animal natural resources and wild life.	**1.** ICT, BIO, DES **2.** BIO, PP
Socio-economic Goal - The strengthening of the Technological Infrastructure and the Transition to a Knowledge Society		
(No sub-categories for this goal are defined)	**1.** Development of computers that do not require user training. **2.** Ensuring high quality service in information management and transfer. **3.** Ensuring information safety in the knowledge society. **4.** Preparation for knowledge and electronic wars. **5.** Development of carrier systems for the 4th generation of mobile communication systems. **6**. Establishing the wide band communication system. **7.** Development of bio-electrical man-machine interfaces. **8.** Satellite applications in communications.	**1.** ICT, NANO, DES **2.** ICT, DES **3.** ICT, NANO, DES **4.** ICT, NANO, DES **5.** ICT **6.** ICT, MAT **7.** ICT, MEC, DES **8.** ICT

*ICT - Information and Communication Technologies, BIO - Biotechnology and Gene Technology, EE -Energy and Environment Technology, MAT-Materials Technologies, MEC –Mechatronics, NANO - Nanotechnology, DES-Design technologies, PP -Production Processes and Systems Technologies.

Source: TÜBİTAK (2004d, pp. 17-35, 60-66; 2004a, pp. 55-74)

According to the method of the foresight exercise, the task to be done after the determination of the technological activity topics was to define the strategic technology areas or 'underpinning technologies'. This task had been accomplished by the panels but at different levels of detail. The reason for this is so explained in the TÜBİTAK documentation (TÜBİTAK, 2004c, p. 77) that the panels did not have members with sufficient expertise in all related technology areas that were connected to a specific technological activity topic. In order to provide clarity, a 'technology areas workshop' was conducted in March 2004 with the participation of new experts in fields where the need was eminent. In this workshop, participative group techniques were used to determine the underpinning technologies for the technological activity topics. The resulting list is a very extensive one, including 480 different underpinning technologies grouped by the project office under the eight headings which were determined to be the 'strategic technologies' (TÜBİTAK, 2004d, pp. 37-47). These are:

1) Information and communication technologies
2) Biotechnology and gene technology
3) Nanotechnology
4) Mechatronics (Robotics, MEMS, Sensors, Basic Control Technologies)
5) Design technologies (Modeling, Simulation, Design software)
6) Technologies related to production processes and systems
7) Materials' Technologies
8) Energy and Environment Technologies

The underpinning technologies were assigned TÜBİTAK technology codes for later use. The synthesis document includes a matrix that maps all technological activity topics to the eight related strategic technologies. The related strategic technologies for each activity topic are given in the third column of Table 4.9.

The distinction of technological activity topics and technology areas (referred to as underpinning technologies in some documents) is throughout confusing and also complicates the final assessment and overview of the foresight result. There are many technological activity topics and technology areas listed in the documentation so that the reader is very likely to loose oversight in what is really considered as important for Turkey. It is essential to understand that technological activity topics are more specific, relating to specific technologies, processes and products that are to be dwelled upon and implemented and create value added, while technology areas designate the common denominators or underpinning technologies that Turkey needs to develop competence in, in order to realize the technological activity topics. While the technological activity topics represent the socio-economic dimension, the demand side, the technology areas or underpinning technologies characterize the scientific aspect or the supply side of science and technology.

The lack of clarity that was experienced during the foresight exercise about the concepts of technological activity topics – technology areas is documented in the minutes of the panel's joint meeting of February 2004 (TÜBİTAK, 2004e). Therein, it is stated that theses concepts were unclear at the beginning so as to cause much confusion and waste of time. Consequently, the time left was not sufficient to allow communication among panel members and different panels for a proper study on the technological activity topics – technology areas issue.

4.4.2.2.5.4 Recommended Science and Technology Policies In Order To Realize the Priorities

The synthesis also involves a compilation of the policy recommendations made by the panels. The policy recommendations were grouped under the following headings:

- Policies for focusing on the priority technology areas.
- Human resources management and education policies.

- Regulatory policies.
- Financial policies.
- Institutional structure policies.

More details on the policy outcome can be seen under Section 4.5.1 - The Vizyon 2023 Strategy Document.

4.4.2.2.6 The Strategic Technology Groups

The final step of the Vizyon 2023 technology foresight exercise was the preparation of roadmaps showing the various stages and the policy tools to be used in reaching the desired competency levels in the strategic technology areas. In pursuance of this task, a strategy group was formed for each strategic technology. Overall, 132 experts participated in the effort. The lists of strategy groups' members are given in Appendix A. The strategic technology groups extended their work over a period of two months from May to July 2004 upon which their final reports were presented to the project office.

Although not written in accordance with a predefined format, the strategic technology groups' reports usually include general assessments of the strategic technology, the roadmaps and some policy recommendations. It needs to be mentioned that the strategic technology groups' definition of strategic technologies, (except for communication and information technologies and mechatronics) can in no obvious way be matched with the technology areas or technological activity topics or the Delphi statements that had resulted from the panels' work. But, this is to be expected in this kind of methodology since, the panel work and technological activity topics represent the demand side while the strategy groups' work represents the supply side of science and technology. It also should be noted that there is only an indirect connection of the outcome of the strategy group's strategic technologies to the strategic technology criteria that had been established by the steering committee for the Delphi survey. The strategic technology groups' work should be regarded as that of independent expert panels, seeking only a narrow consultation within the group itself.

The subfields under which road maps were created by the strategic technology groups are given in below Table 4.10. The roadmaps show the milestones that have to be reached in the period from 2005 to 2023 in basic research, applied research, industrial research and industrial development with respect to the strategic technology area.

Table 4.10: The Strategic Technologies

Information and Communication Technologies Integrated Circuit Design and Production Technologies Image Units (Monitors) Production Technologies Wideband Technologies Image Sensors Production Technologies
Biotechnology and Gene Technology High-Scale Platform Technologies, Structural and Functional Genome Science, Transcriptomics, Proteomics and Metabolomics Recombinant DNA Technologies Cell Treatment and Stem Cell Technologies Drug Scanning and Design Technologies Therapeutic Protein Production and Controlled Release Systems Bioinformatics
Nanotechnology Nanophotonics, Nanoelectronics, Nanomagnetism Nanomaterials Nanocharacterization Nanofabrication Quantum Information Processing on Nano Scale Nanobiotechnology
Mechatronics Micro / Nano Electromechanical Systems And Sensors Robotics And Automation Technologies Basic Control Technologies and Other Generic Areas
Design Technologies Virtual Reality Software and Virtual Prototyping Simulation and Modeling Software Grid Technologies and Parallel and Distributed Computing Software
Technologies Related to Production Processes and Systems Flexible and Agile Manufacturing Technologies Rapid Prototyping Technologies Surface, Interface, Thin Film and Vacuum Technologies Metal Shaping Technologies Plastic Parts Manufacturing Technologies Welding Technologies High Speed Machining Technologies

Table 4.10 (continued): The Strategic Technologies

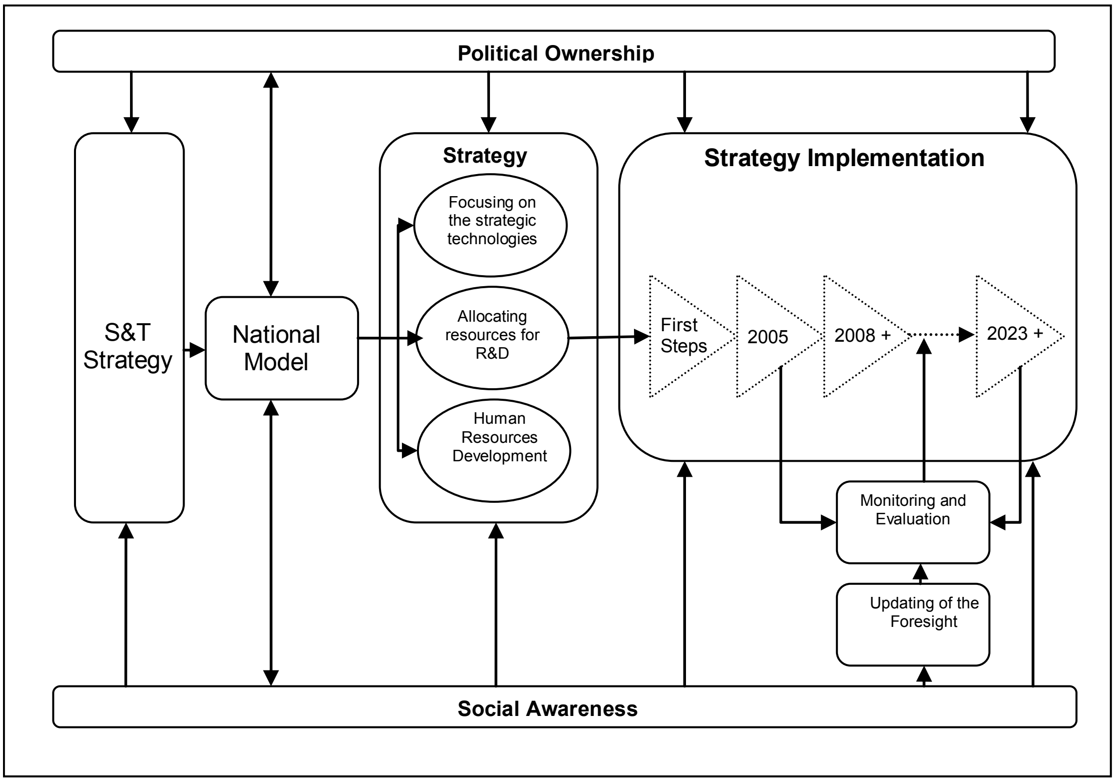
Materials' Technologies Boron Technologies Composite Materials' Technologies Polymer Technologies Smart Materials' Technologies Magnetic, Electronic, Optoelectronic Materials Technologies Light and High Strength Materials' Technologies
Energy And Environment Technologies Hydrogen Technologies And Fuel Cells Renewable Energy Technologies Energy Storage Technologies and Power Electronics Nuclear Energy Technologies Environment Sensitive and High Efficiency Fuel and Fuel Combustion Technologies Water Purification Technologies Waste Management Technologies

Source: TÜBİTAK (2004a, pp. 33-34)

4.5 Vizyon 2023 – The Policy Link

4.5.1 The Vizyon 2023 Strategy Document

The strategy document (TÜBİTAK, 2004a) comprises of 2 parts and 4 appendices. The first part of the strategy document repeats the findings of the synthesis and lists the vision, the socio-economic goals that support this vision, the priority technological activity topics that Turkey needs to develop competency in, to achieve these goals, and the strategic technologies. The wording used is slightly different than that of the synthesis document but the essence is the same. The document also includes brief descriptions and the significance of the 8 strategic technologies. The second part of the strategy document is dedicated to the national S&T strategy that was developed on the basis of the technology foresight project. The model of the strategy developed is shown schematically in Figure 4.6 and highlights are pointed out below.



Source: TÜBİTAK (2004a, p. 27)

Figure 4.6: The Model of the S&T Strategy

The aim of the strategy is, as the document points out, to make the 2023 vision achievable by the virtue of S&T. However, in order to be able to use S&T as a strategic instrument, it is essential that this instrument is available in the first place. Once there is dominance in S&T, the task is then to use it for economic and social benefit.

In order to use scarce resources in the most efficient way, the strategy document proposes a strategy that rests on three pillars (TÜBİTAK, 2004a, pp. 29-30).

The first pillar of the proposed S&T strategy is the 'focus on the strategic technologies'. This focus entails the following three elements:

- The priority in allocating the public funds reserved for R&D need to be given to the strategic technologies and the scientific research areas that support these strategic technologies.
- Researchers, universities and other research institutions as well as industrial organizations need to be encouraged and motivated to undertake research in the strategic technologies and cooperate with each other.
- Planning related to intellectual development, in particular the education and research programs and PhD and post-PhD scholarships need to be oriented to the strategic technologies.

In other words, ‘focusing’ is in fact creating the Turkish Research Area that can be integrated to the European Research Area on the basis of the strategic technologies. Another dimension of focusing is to establish the relationship between the strategic technologies and the technological activity topics that will yield social and economic benefit.

The second pillar of the strategy is the establishment of networks of cooperation on the strategic technologies that are to be focused upon. These networks of cooperation are structures that bring together on organizational and individual level those that take part in the research effort and those that can convert the research results to social benefit. Here, the orchestration and the task of forming the medium (techno-parks, incubators) and organizations (intermediary organizations, innovation relay centers) that enable the interface and pave the wave for this cooperation falls upon the government.

The third pillar of the strategy is the need to manage the focusing process in a systemic coherence. The polices for gaining competency in science, technology and innovation, can only be implemented by a holistic approach that connects these to the countries’ policies from education to tax polices industry and investment polices and all other polices to each other.

The strategy document further stresses the importance of forming a knowledge economy whose backbone is the national innovation system (TÜBİTAK, 2004a, p. 31).

Three approaches are deemed as essential for the success of the proposed strategy:

1) The political approach – It is asserted that the strategy can only be implemented by the will, decisiveness and continuous support of the political authority.
2) The public administration approach – All governmental organizations and employees need to be made aware of Vizyon 2023 and its goals.
3) The social awareness approach – It is essential that in all segments of society the awareness about the activities and goals to pursue for the transformation to a knowledge-based economy must rise.

The strategy for acquiring competency in science technology and innovation thus comprises of the following elements (TÜBİTAK, 2004a, p. 32):

- Focusing on the strategic technologies and the scientific research areas that support these strategic technologies.
- Allocating resources to R&D
- Developing the necessary human resources and allocating resources for this purpose
- Political ownership
- Creating awareness in all segments of society
- Monitoring the progress and evaluating the results of Vizyon 2023 and establishing a continuous foresight system.
- Establishing a system that allows the review of Vizyon 2023 in certain intervals of time by taking into consideration new developments in science and technology, changing socio-economic context and results obtained from implementation.

To facilitate the focusing on the strategic technologies, the usage of three policy tools is proposed (TÜBİTAK, 2004a, pp. 36-39):

1) Public Procurement and defense procurement based on R&D – Public procurement policy should be based on furthering R&D and strategic priorities. State procurement laws should be revised so as to support this approach. Defense procurement should be based on national security, not on free market competition and should thus be done locally. 'National main contractor' approach should be introduced in the procurement of major defense systems.
2) National R&D Fund - National R&D Program – Entails the creation of the Turkish Research Area and the creation of a fund similar to the EU's framework programs to support the national research program.
3) Guided R&D Projects - Projects that are commissioned by the ministries and other governmental organizations are seen as an important tool to enhance competency in the strategic technologies.

The strategy document further elaborates on the 'allocating resources for R&D' and 'human resources development' strategies, by establishing the goals in numbers. Furthermore, the criteria for measuring the progress and performance of the strategy are indicated as below (TÜBİTAK, 2004a, p. 42):

- The number of scientific publications per million population.
- The number of patent applications to the European patent office.
- The patents granted from the US patent office.
- The total number of triadic patents
- The share of products with high technology content in total exports.

- The share of technology export within GDP.
- The share of added value created in high and medium-level technology industry to total added value.
- The share of employment in high and medium-level technology industry to total employment.
- The rate of added value in the knowledge intensive services sector.
- The rate of employment in the knowledge intensive services sector.

As to the implementation of the strategy, the document concludes that this is only possible by the coordination and cooperation of all of Turkey's organizations, under the coordination of TÜBİTAK (TÜBİTAK, 2004a, p.43).

4.5.2 The BTYK Decisions

The progress of the Vizyon 2023 project has throughout been monitored in the meetings of BTYK. Below, we will examine the BTYK decisions that are related to the Vizyon 2023 technology foresight exercise and the follow up strategy formulation process.

As had been previously mentioned, the project framework was finalized in the 7th meeting of the Council in 2001, In the 8th meeting of 2002, the Council's decision elaborates on the progress of the project and lists all major activities so far as to the decisions of the establishment of the socio-economic panels. In the same meeting, the projects budget is approved. In the Council's 9th meeting in February 2003, no decisions were taken but, the agenda is documented in the preparatory meeting notes, which includes a section on the progress of the Vizyon 2023 project. This meeting had taken place at the time when the panels' work was still in progress, before the Delphi survey implementation. It is stated that upon the conclusion of all sub-projects by mid-year 2003, the preparations for the strategy document are due to start.

BTYK's 10th meeting was held in September 2004. The decisions of this meeting announce the conclusion of the Vizyon 2023 technology foresight sub-project, report on the progress of the other sub-projects and confirm that the finalized strategy document version 17 was presented to the Council[1]. In the same meeting a new decision was taken that demanded the preparation of a National S&T policy implementation plan for the period of 2005-2010. The responsible organizations were designated as TÜBİTAK and DPT. The decision states that TÜBİTAK is to evaluate first the Vizyon 2023 project against the existing development plans and annual plans, collect the opinions of the organizations that are members to the BTYK, finalize the strategy document accordingly and present it to the Council on its 11th meeting in March 2005. Thereafter, TÜBİTAK was assigned the task to prepare the implementation plan (BTYK, 2004, p. 12). It was decided that the implementation plan should take into consideration the following elements (BTYK, 2004, p. 13).

Main objectives – Raising the quality of life of the people, finding solutions to social problems, increasing the competitive strength, extending S&T culture to society.

Main Principles – Strategic approach, result orientation, public-private sector cooperation, effectiveness, participation, accountability, consistency of authority and responsibility, flexibility.

Main goals – Increasing the demand for R&D, Increasing the number and qualification of scientists, professional and technical human resources, increasing the share of R&D expenditure within the GDP.

In accordance with these main goals it was also decided that the necessary public funding will be allocated to increase the R&D expenditure to 2% of the GDP and measures will be taken to increase the number of full time equivalent researchers to 40,000 by the year 2010. The rationale of the decision indicates that Turkey was not yet at the place it deserves in R&D, because so far, national priorities had not been clearly defined, there had

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[1] The most current version that is listed on the TÜBİTAK web-site is version 19.

been ambiguity of understanding what the objectives and goals were and the connection of the activities of government, private sector and universities were uncoordinated. It was therefore deemed necessary that the R&D efforts be focused upon the objectives of increasing the welfare of the country, finding solutions to social and economic problems, increasing the competitive power and promoting S&T's importance to the people. To attain these objectives, all R&D activities needed to be result and performance oriented. Therefore, it was necessary to devise a S&T strategy, which was followed by all organizations (BTYK, 2004 pp. 12-13). This statement can be taken to constitute the groundwork for the definition of the 'Turkish Research Area' which was referred to as 'TARAL' later on. TARAL implies all actors from the public and private sectors, NGO's and universities that engage in S&T activity and research and are to take part in the implementation of the strategy, in a coordinated manner.

The decisions taken in the 10^{th} BTYK meeting indicate that the strategy formulation process is not considered as complete but is still ongoing.

The 11^{th} BTYK meeting held in March 2005, resulted in a series of new decisions that were connected to the new S&T strategy. By the time of the meeting the opinions of the governmental organizations as regards the strategy document had been gathered and evaluated. The result of his survey was also included in the meetings' documentation. Most opinions submitted were on policy level expressing some particular demands, and few on technology level. The most severe critique was raised by the Under-secretariat of Foreign Trade, expressing the opinion that the strategy document was in the form of a declaration of intentions, does not include concrete plans or instruments and that the roadmaps are in lack of implementation principles (BTYK, 2005a, p. 14).

The decisions of this meeting include in the annex a proposal for a national research program that we learn was drafted in a workshop held in November 2004 (BTYK, 2005a). This draft includes five categories, under which the national program will be developed and the level of research required for its sub-categories, namely - information and communication technologies, biotechnology and gene technology, new products and production processes, nanotechnology and materials technologies, energy and environment technologies. It can be observed that this list, with some minor adjustments, coincides by and large with the strategic technologies determined by the strategic technology groups and is printed in the strategy document.

Among the new decisions taken in the 11th meeting one was concerned with the national S&T vision. As explained earlier, a vision had been created and incorporated in the synthesis as well as the strategy document. The BTYK documentation includes a new vision statement. The decision indicates that the vision had been discussed in a meeting in March 2004 alongside the strengths, weaknesses, opportunities and threats of the national science and technology system and was later agreed upon (BTYK, 2005a, p. 32). This vision is to be:

"A leading country that ensures the adoption of an S&T culture and raises a sustainable standard of life by converting science and technology to product". According to the explanation of the decision, this vision is formulated in the context of TARAL, but is obviously also a correction of the patched up version that was previously formulated. Unlike the version that was suggested in the aforementioned documents, it is much clearer, shorter and genuine enough to be recognized as a vision statement.

The next decision taken in the 11th meeting was concerned with the national science and technology systems' performance indicators. The list of performance indicators that are given in the BTYK decision is a more extensive one than the list suggested in the strategy document, also including for instance innovation performance indicators for SME's.

The priority technological activity topics and underpinning technologies that were determined in the foresight exercise and included in the strategy document comprise another decision of the 11th BTYK meeting, (BTYK, 2005a. pp. 37-59) thereby becoming an official element of Turkish S&T policy (See Table 4.9). Further new decisions of the BTYK 11th meeting are the preparation of a National Public Research Program, the determination of policies governing the usage of TÜBİTAK's R&D funds in the year 2005, the usage of OECD's Frascati, Oslo and Canberra Manuals as reference in R&D activities, the definition of a National Defense Research Program, and the definition of a National Space Research Program (BTYK, 2005a, pp. 37-59).

The 2005-2010 implementation plan constitutes an annex to the BTYK 11th meeting decisions and is thereby approved. The implementation plan defines seven activity areas, as follows:

1. S&T awareness and culture development.
2. Scientific human resources development.
3. Support of result oriented, high quality research.
4. Effective national S&T management.
5. Strengthening the S&T performance of the private sector.
6. R&D infrastructure development.
7. Development of effective national and international connections.

The plan further elaborates the activities under these activity areas with sub-items merely pointing to general directions rather than specifying the concrete tasks, responsible organizations, the resources allocated and the timeframe for completing the tasks. For instance, some of the activities listed under the 'scientific human resources development' activity area and 'increasing the number of researchers sub-item' are:

- Effecting measures for motivating researchers in SME's,
- Enhancing the support provided to researchers in the private sector,
- Supporting the formation of innovative companies,
- Increasing the capacity for graduate education (BTYK, 2005a, pp. 68-80).

In this form, the 2005-2010 implementation plan is more in the essence of another strategy document rather than a plan.

The 12th meeting of BTYK in September 2005 includes a follow-up on the implementation plan, the national S&T vision and the national priority areas of S&T. The explanation with respect to the implementation plan states that now additional funding from the 2005 budget has been allocated in line with the decision to increase the R&D expenditure to 2% of the GDP and support measures are already effected in order to increase the number of full time equivalent researchers to 40,000 by the year 2010 (BTYK, 2005b, p. 3). The explanation of the vision statement decision includes a listing of activities that have been undertaken in terms of promoting S&T culture to the public as emphasized in the vision. Furthermore, various important improvements in the R&D support regulations, particularly encouraging university and industry cooperation, are reported to be made, in accordance with the reference in the vision statement to 'converting S&T to product'.

With respect to the national priority areas of S&T, it is explained that a circular No. 2005/9 dated 14 April 2005 has been issued and distributed by the prime ministry, informing all public organizations under TARAL that in the usage of public funding for R&D and in the planning of graduate study and scholarship programs in universities, precedence should be given to the priority technology areas, public research organizations should be motivated to undertake research that supports those priority technology areas in cooperation with the private sector. The annex of the circular includes the BTYK 11th meeting decisions document. The circular also calls upon the public organizations to prepare and detail R&D programs in accordance with their needs and submit these to TÜBİTAK. In the same explanation there is also a statement about the necessity to update the priority technology areas in certain periods of time. It is conveyed that TÜBİTAK is already engaged in a preparatory work for a new technology foresight project (BTYK, 2005b, pp. 5-6).

In the 12th BTYK meeting, a new decision is taken about the goals for the year 2010 for the national S&T system. These goals are determined and presented in numerical form by considering the indicators of developed countries (Germany, Italy, Spain, South Korea, Japan, USA the EU and the OECD total) as derived from the 'OECD Main Science and Technology Indicators', the 'EU Trend-chart in Innovation Indicators', the 'World Development Index' and the 'World Competitiveness Report'. For instance, it is aimed that Turkey's general rank in competitiveness is raised from 48 in the year 2005 to rank 35 by the year 2010, where according to the same indicator, Germany's is at rank 23, Italy at 53, Spain at 38, South Korea at 29, Japan at 21, and the US at rank 1 (BTYK, 2005b, p. 29).

The latest BTYK meeting to date took place in March 2006. Again, the meetings' documentation includes a follow-up of the developments that had taken place with regard to the previous decisions. It is, for instance, stated that Turkey's standing in achieving the goals with respect to the science, technology and innovation system, as decided in the 12th meeting will be continuously monitored. We also learn that up until February 2006, 29 public organizations had submitted 142 project proposals under the national public research program that was announced in the 11th meeting of the Council. In the meantime, 11 of these projects had been accepted and granted support (BTYK, 2006, p. 15). As for the national defense research program, extensive effort was taken to formulate defense and space projects with the cooperation of the related organizations (Chief of Staff, Ministry of Defense, Undersecretariat of Defense Industry) and TÜBİTAK. The result was that 26 projects were proposed to TÜBİTAK of which 4 are already contracted (BTYK, 2006, p. 22). The efforts under the national space research program are also reported to continue, with 238 projects presented to TÜBİTAK.

In the 13th meetings' documentation, a whole section is dedicated to the developments concerning the 2005-2010 implementation plan, listing in detail the progress achieved under each activity area. It is also conveyed that a survey about the activities of TARAL actors in the year 2005 and their planned activities and needs for the year 2006 had been conducted, having at the same time the purpose of raising the awareness about the implementation plan. A preliminary assessment of the survey result is annexed to the meetings' documentation (BTYK, 2006, p. 49).

4.6 Concluding Remarks

In Chapter IV, we have,

- reviewed Turkey's background in S&T policy,
- examined and described the process, method and results of the Vizyon 2023 technology foresight project,
- examined the linkage of the Vizyon 2023 technology foresight to policy by describing the Vizyon 2023 strategy document and the BTYK decisions.

We will below briefly outline the main findings of Chapter IV.

Turkey recognized the importance of S&T and consequently S&T policy as a driver of socio-economic development very early, but was not likewise successful in the implementation, as in the formulation of S&T policies.

The Vizyon 2023 technology foresight was aimed at providing input for a new long-term S&T strategy for Turkey. The project was authorized by the Supreme Council of Science and Technology (BTYK), Turkey's foremost authority of S&T policy making, and implemented by, the Scientific and Technical Research Council of Turkey (TÜBİTAK), in conjunction with a large number of relevant organizations represented in the projects' steering and executive committees. It cannot be deduced that the level of coordination and cooperation of these organizations for the project was at a satisfactory level.

The Vizyon 2023 technology foresight project was carefully planned and successfully implemented by TÜBİTAK. Vizyon 2023, was designed to incorporate a holistic approach, including vision-building, determination of socio-economic goals, identification of strategic technologies and formulation of policy recommendations. The methodologies used included expert panels and a Delphi survey. After the Vizyon 2023 technology foresight project was concluded, its results were used to prepare a long term strategy for Turkey. The Vizyon 2023 strategy document was finalized and presented to the BTYK. The reports of the socio-economic panels and the strategy groups should also be considered as a significant outcome of Vizyon 2023.

The outcome of Vizyon 2023 in terms of important technologies is given by three lists. The first list includes the 65 technological activity topics identified by the panels, representing the S&T demand side. The second list includes the underpinning technologies grouped under the 8 headings of the strategic technologies. The third list is an elaboration of the second list, defining sub-areas under the 8 headings for strategic technology areas and representing the supply side of S&T. It is difficult to understand this scheme, and the interconnection of the items in each list. This difficulty is likely to cause problems in the implementation of the S&T strategy that is among other elements, based on focusing on the strategic technologies.

In a reading of the BTYK decisions, it is possible to trace the progress of the technology foresight, the strategy formulation and the follow up implementation efforts. The decisions taken by the BTYK demonstrate support during the foresight implementation phase and for the Vizyon 2023 strategy later on. Still, this is no guarantee for the success of the implementation to follow.

In Chapter V, we will analyze the strengths and weaknesses of the Vizyon 2023 technology foresight and provide some policy recommendations.

CHAPTER V

A CRITIQUE AND POLICY RECOMMENDATIONS

5.1 The Strengths and Weaknesses of the Turkish Foresight

The strengths of the Vizyon 2023 technology foresight are:

Strong Link to Policy: The Turkish foresight study, being a project that was decided by the BTYK, Turkey's foremost S&T policymaking authority chaired by the prime minister, had a strong link to policy and has enjoyed strong political support. The foresight results and the strategy developed gained official status by the prompt decisions of the Council. The implementation is still continuing under the authority of the BTYK.

Holistic Approach: The foresight exercise was designed taking a holistic approach including vision-building, identification of goals, identification of strategic technologies as well as the objective of achieving process effects. The appropriateness of the foresight approach naturally depends on its context. In the Turkish case, a holistic approach was suitable since this was the first national foresight exercise and it was necessary to elaborate on the countries' vision with respect to S&T as well as to identify priority technologies and to develop strategy and policy advice, while at the same time it was to serve as a learning process. Previous policies had been developed on the premises of the examples set by developed countries. It was therefore significant to develop a holistic foresight approach, tailored to Turkey's needs.

Efficient Program Management: Organizing a national foresight study is a grand and complicated endeavor, involving the coordination of many actors and resources. The task is even a more challenging one when there is an acknowledged deficiency of coordination, an unwillingness to cooperate among public bodies and various actors that are stakeholders to the Turkish science, technology and innovation system. The project was well executed - all deliverables (panel meetings, reports, Delphi survey, synthesis, strategy document etc.) were met. During the execution of the foresight, extensive use was made of the Internet especially in the conduct of the Delphi Survey. The documentation of the project is adequate. Nevertheless, as expected in any such kind of endeavor, critique was raised about the project management. This critique is documented in the meeting minutes of the joint meeting of the panels held in February 2004. The minutes contain statements such as that the project management was not systematic enough, the project office lacked to supply sufficient documentation to the panels, the time allocated for the panels work was insufficient, etc. (TÜBİTAK, 2004e). A major flaw of the Vizyon 2023 project is that the other three sub-projects were not completed in time so as to provide input to the technology foresight project as originally planned. Aside of these critiques, the impression one gets is that the technology foresight project was managed efficiently.

The weaknesses of the Vizyon 2023 technology foresight are:

Poor Dissemination and Public Promotion During and After the Foresight: We had previously indicated that the time allocated for the diffusion effort during the foresight exercise had been very short and the number of activities not sufficient. The same pattern continued after the completion of the foresight project. It can hardly be claimed that TÜBİTAK has succeeded in creating awareness and excitement about the foresight in the Turkish public opinion. The foresight is not even known and appreciated in academic circles. Although the strong link of the foresight program to the policy is taken to be a strength, it appears that the technology foresight has vanished within the policy process altogether. The international promotion of the project also appears poor. There is no detailed documentation of the project in English language only some information appears on the TÜBİTAK website. It would probably have been proficient to form and engage a separate group in the promotion activities of the Vizyon 2023 foresight.

Lack of a Macro Vision: Vision-building in foresight can be done at sectoral level or by using scenarios or megatrends at either sectoral or national level (Gavigan and Scapolo, 1999) and there are national examples of either. Thus, the lack of a macro-vision as indicated should not be understood to comprise a methodological failure. Nevertheless, as indicated in section 4.4.2.2.5.2, a need for a national vision, a framework to which the panels could adjust was felt and expressed. The same situation had been encountered in the Hungarian case, whereupon the foresight process had evolved to include macro-scenarios. In the Turkish case, it would have made sense to incorporate such an approach from the beginning, since Turkey is a country with many options still open - such as whether Turkey will become a full-member of the EU or not. It would have made sense to contemplate on these different options and develop strategies accordingly.

No Resulting Clear Messages Due To Lack of Program Level Prioritization: Again, this should not be understood as a suggestion of methodological failure but as a critique raised against a choice. As the classical definition of Martin (1995) states, foresight has the aim of identifying emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic and social benefits. When these technologies are identified which can constitute a crowded list to begin with, the question whether to prioritize these or not and at what level such prioritazion should occur, arises. There are several different approaches to prioritization in a foresight exercise. We have examined the example of the French foresight which was based on a 'critical technologies' approach and two rounds of voting with two different sets of criteria. In the Turkish exercise an approach similar to the one used in the UK foresight program, as documented by Keenan (2003a), was taken.

The level of prioritization can be on panel or program levels both of which have their advantages and disadvantages. The advantage of panel level prioritization is its credibility, at least within the S&T communities, since it is carried out only by experts in a given area. Its disadvantage is that cross-panel issues are likely to be missed if no attempts are made to draw elements together at the program level. Furthermore there is the likeliness of inconsistency in application of prioritization criteria across panels. The advantage of program level prioritization is that cross-panel topics are given the space to emerge and clear messages can result that lend a program political weight. The disadvantage is that questions of credibility, legitimacy and authority arise as to who decides on the program level what these priorities are. An overload of data will be faced and there is the threat that justice is not done to the panels' findings, and over-distillation of foresight findings may result (Keenan, 2003a; Keenan, 2003b).

In the Turkish case, the steering committee had decided on a set of 5 strategic technology criteria for prioritization and had assigned a weight to each criterion. The panels acted autonomously and chose their own prioritization criteria for the technological activity topics. The strategic technology criteria in conjunction with the assigned weights were used in the Delphi Survey to prioritize the Delphi statements, according to the importance index. The panels in turn made use of the Delphi survey results in the prioritization of their findings. The overall result is 65 technological activity topics and 480 underpinning technologies grouped under 8 headings to comprise the 'strategic technologies'. These numbers may not be in excess of other countries' foresight results. For instance, the first round of foresight in the UK resulted in - 360 sectoral priorities, 27 generic S&T priorities grouped under 6 headings and 18 generic infrastructural priorities grouped under 5 headings (Keenan, 2003a). However, there is then the problem of 'granularity'. According to Keenan (2003a) attempts of identifying critical technology lists in countries had highlighted the problem of what the degree of 'granularity' of the discrete technology areas to be prioritized should be. There has to be a compromise of two opposing tendencies:

1) The need to generate a list of technologies detailed enough to yield specific policy implications; and,
2) The need to avoid generating an extremely long and complex list that would require excessive amounts of effort to evaluate (Keenan, 2003a).

The technological activity topics in the Turkish case are broadly defined and include items such as ‘nuclear energy production’ or ‘ensuring food safety and reliability’ or ‘production of micro-electromechanical systems (MEMS) and digital integrated circuits’. In case of the latter one could ask for what purpose the digital integrated circuits would be produced, because there is a wide range of applications and different processes and technologies will be employed for digital integrated circuits that will be used in space travel and military equipment and that will be used in personal computers.

Considering above explanations, the impression with the Turkish foresight result is that it is difficult to draw a conclusion as to what is considered as priority for Turkey. There are too many directions that are pointed to by the foresight result, which includes ‘everything’ from agricultural machines to critical weapons, ammunition and safety systems to nuclear energy production and to space vehicles all of which constitute major decisions and investments against the scarce resources. The 8 strategic technologies are again too general to act upon and it would be difficult to classify any current endeavor in S&T as not being within the range of one of these. The conclusion thus reached is that a program level prioritization in the Turkish case would have been beneficial.

5.2 Policy Recommendations

Below we have outlined five policy recommendations that are considered as significant, in the success of the Vizyon 2023 strategy and the implementation agenda to follow.

1) Evaluate Foresight: The Turkish technology foresight exercise herein is described on the basis of the documentation made available by TÜBİTAK, which nonetheless proves to be extensive. As such, the critique given above is solely based on the examination of literature and available documentation, whereas it must be substantiated that 'insider' information should be considered valuable in passing any judgment about foresight studies. This is because technology foresight is a process in which the benefits of it are considered as important as the results themselves. It is a learning process. Hence, the knowledge of the difficulties that were encountered while conducting the foresight exercise and the solutions developed during this process by those who were directly involved should be valuable in aiding to design and implement further foresight exercises in Turkey and link them to policy later on. Our first recommendation thus entails that TÜBİTAK, if not already existent, should prepare a 'lessons learned' document that outlines the major lessons drawn from the execution of the first national technology foresight project. Secondly, in a broader context, a formal evaluation of the technology foresight should be planned and carried out. This can be very significant since 'updating the foresight' is mentioned in the Vizyon 2023 strategy document and as we have learned from the 13th BTYK meeting decisions, TÜBİTAK is making preparations to renew the foresight exercise. According to Georghiou and Keenan (2005), foresight being a policy instrument that consumes time and resources, it should be subject to evaluation on the following aspects:

- Accountability—with questions such as whether the activity was efficiently conducted and proper use made of public funds;
- Justification—with questions such as whether the effects of foresight justify its continuation and extension; and
- Learning—asking how foresight can be done better in particular circumstances (Georghiou and Keenan, 2005).

There exist some frameworks of foresight evaluation, also one recently published by the aforementioned authors on assessing foresight against its rationale, process and impact. Some countries like Austria, Germany, Hungary, Japan and the UK have already completed an evaluation of their foresight programs, each using different evaluation approaches (Georghiou and Keenan, 2005). Table 5.1 provides a listing of some examples of rationales of foresight and associated evaluation issues.

In the Turkish case, the rationale considered would clearly be 'providing policy advice' with the matching evaluation focus indicated in Table 5.1.

From another point of view, the characteristic of the Turkish foresight being a second generation foresight program may be the focus point of the evaluation. Key evaluation issues in the second generation are the take-up of priorities and establishment of networks among the industrial and academic participants (Georghiou and Keenan, 2005). This would as well entail an assessment of the process effect of foresight, which at present we have no information to judge upon.

Table 5.1: Some Examples of Rationale for Foresight and Associated Evaluation Issues

Rationale for foresight	What does it do?	Expected outcomes?	Evaluation focus?
Providing policy advice	Highlights the longer term and extends perspectives	Policy decisions, resource allocations More rational decision making over space and time	Attribution of decisions to foresight exercise Changes in decision-making processes
Building advocacy coalitions	Highlights challenges in an interaction space around which interest groups coalesce	New emerging networks and communities Wide commitment to realization of a shared vision	Nature of networks Actions undertaken by them
Providing social forums	Provides a hybrid forum for strategic reflection, debate and action	Broadened participation, democratic renewal	Numbers and breadth of actors involved Focus and quality of debates Benefits to participants

Source: Georghiou and Keenan (2005)

2) Create Regional Development Policies Based on Foresight: While examining the foresight exercises of France and Hungary in Chapter III, we had learned that foresight results had been considered in the regional context. In the French case the scientific and technological potential of each region was to be evaluated in terms of the key technologies identified in the foresight exercise. In Hungary, regional workshops had been organized to discuss the results of TEP.

Considering the importance of the regional focus in present S&T policy, a similar approach could be taken in Turkey by examining the foresight results in a regional development context and determining the technologies to support and policies on a regional basis.

3*) Increase the Number and Diversity of S&T Policy Implementation Programs and Instruments:* As much as there is need to coordinate the policy and strategy formulation and planning processes, there is also a need to decentralize or extend the implementation to the various actors of the Turkish Research Area and National Innovation System. TÜBİTAK should not be the only organization involved and responsible in the implementation of the strategy and organizations within the national innovation system should be motivated to assume ownership and responsibility. There have to be mechanisms that lead the strategy back to the level of the individuals, to the researcher, the university, the governmental organization, the firm, the entrepreneur, the financing institution, and NGO's. TÜBİTAK and organizations like TTGV already have various support programs for universities, industry and public organizations but there is a need to broaden and diversify these in accordance with the new strategy. Under the new Vizyon 2023 strategy, steps have been taken to facilitate the creation of new programs such as the national research program, the national public research program and the national defense research program. Further effort must be made not only to increase the variety of these programs but also to develop diverse instruments that motivate the involvement of various actors to these programs. Here, we are not speaking about science or technology development projects and neither about research and educational support of any kind, but of programs that serve the objectives of the new strategy and create networking effects. The

EU's 6^{th} Framework Program (FP6) is a good example. The different types of projects and actions to implement FP6 are also known as the instruments. There is a number of different instruments for multi-partner research activities, special types of projects for SME's, support for utilizing and developing large scale research infrastructures etc. such as Network of Excellence (NoE), Integrated Project (IP), Specific Targeted Research Projects (STREP), and Specific Targeted Innovation Projects (STIP), Specific research projects for SMEs, etc. The various actors should be encouraged to develop different programs on their own and suggest and use different instruments themselves. A good example could be the 'science and society' subject. The need for creating awareness about science and technology and its role in the welfare of the society is pronounced in the Vizyon 2023 strategy document and also constitutes an action item in the 2005-2010 implementation plan. It is also mentioned in the report of the special expertise commission for science and technology in preparation of the Ninth Development Plan. It would be sensible to leave this task to the universities who have the means to interface the science community with the wider public. It would hence be feasible to develop a science and society program with different instruments that universities or university networks can make use of.

4) Improve 'Project Management' Awareness and Knowledge: Research and technology development are nowadays done in units of projects. Research and development ripe for and applicant of funding is always formulated in terms of a project. As a matter of fact, the formulation of research into a project, as scientists and engineers would acknowledge is a difficult part of the research and development effort itself. It is not possible to claim the allocation of resources by purely declaring that research and technology development is to be undertaken in certain scientific or technological areas/fields. The allocation of resources most of the times is not done to a field of science and technology, but to a certain project.

The quality and superiority of a project does not depend solely on the technology area that it draws upon. It is the way of the organization of the human endeavor that leads to effective results, the timely and appropriate allocation of financial resources, the logistics and tactics that underline the implementation are factors that contribute a great deal to its success. Thus, in order to evaluate a project in terms of the benefit it will generate it is not sufficient to compare it against a list of technologies. On the contrary judging the project only in terms of the fields of technology may lead to false conclusions and eventually a waste of resources.

The Delphi survey results confirm this notion as 'R&D project support' was chosen to be the most preferred policy tool by all participants. The prime minister in his opening speech to the 13th BTYK meeting has also touched upon this subject and declared that project preparation and project management capabilities need to be improved and governmental organizations as well professional organizations are invited to make due contributions to this effort. Hence, policies and strategies that improve 'project management' awareness and knowledge are recommended to support the Vizyon 2023 strategy.

5) Enhance Coordination of Governmental Organizations: In Chapter IV, we had followed the developments with respect to the Vizyon 2023 foresight project up until the issue of the strategy document and further to the latest BTYK meeting. Judging on the basis of this evidence it appears that the link to policy had been successful and proper follow up decisions were taken, including for instance the formation of a national public research program. Whether the decisions of the BTYK guarantee a successful implementation of the S&T strategy is however another question. Göker (2005), after providing a long compilation of S&T strategy and policy designs made by governmental organizations or by the initiative of non-governmental organizations in Turkey, points out that the new Vizyon 2023 S&T strategy is about to face the same destiny of previous S&T policies in Turkey, namely that of being archived and forgotten. Göker (2005) bases this statement on his observation that if the BTYK decisions are carefully examined as a whole, the priorities determined in the foresight are not properly supported. This observation does not necessarily comply with the findings of this thesis. Another observation of Göker (2005) however is that the strategies formulated as a result of Vizyon 2023 have not been taken into consideration in the interim plan of DPT covering the period 2006-2008. Göker (2005), furthermore, states that in the preparatory efforts for DPT's Ninth Development Plan to cover the period of 2007-2013, the listing of special expertise commissions also does not comply with the priorities set by the Vizyon 2023 strategy document. Göker (2005) concludes that a strategy that is not taken into account in short and medium term plans has no chance of being implemented in the long term.

The report of the special expertise commission for science and technology for DPT's Ninth Development Plan does reference the Vizyon 2023 strategy document and the priority activity topics and technology areas but also includes a new vision for the year 2013 and a new strategy formulation (DPT, 2006). There is, however, no mention of the implementation plan that had been prepared by TÜBİTAK for the period of 2005-2010. Another interesting point is that this report also states that Turkey has been able to develop valid and effective S&T policies throughout but was not sufficiently successful in implementing these. In this regard the report highlights the importance of making a due distribution of duties and responsibilities among organizations, ensuring that these organizations assume ownership of these duties and responsibilities and cooperation among the organizations is achieved.

In Chapter II, we had established that policies, strategies and plans are different concepts and it is important to distinguish these. It appears that in Turkey there is great confusion about which organization is responsible to what extend of the formulation and implementation of policies, strategies and plans. There are clashes of organizational responsibilities with respect to either. The role of TÜBİTAK in policy and strategy formulation, coordination of policy implementation, project selection and support, project financing, engaging in research itself as a research organization, evaluation and monitoring of the S&T system, has to be clarified with respect to other governmental organizations in the first place. An accusation of lacking political ownership for policies, strategies and plans can hardly be justified at this point, when there are already ownership problems at the bureaucratic level. It appears that there is little coordination of organizations and policies made by different organizations and no mechanisms to ensure compatibility among these in Turkey. Since this is not a thesis on public administration we shall refrain from making too severe comments on this subject any further but repeat the statement in the Vizyon 2023 strategy document - 'science, technology and innovation polices, can only be implemented by a holistic approach that connects these to the countries' policies from education to tax polices to industry and investment polices and all other polices to each other.'

The ultimate policy recommendation then is that efficient mechanisms must be developed that ensure coherence in Turkey's policies; strategies and plans and their implementation in a coordinated manner. Otherwise, the Vizyon 2023 strategy is destined to fail or only partly succeed, as in previous cases.

CHAPTER VI

CONCLUSIONS

The aim of this thesis was to examine and describe the Turkish technology foresight study and draw conclusions about its effect on the Turkish science, technology and innovation system.

Technology foresight has recently gained widespread popularity across Europe and all over the world as a policy tool used in identifying future technologies, setting research and development priorities and formulating science and technology policies. It is closely related to future studies, strategic planning and policy analysis and draws upon the concepts, knowledge and methodology of these fields. Foresight takes a proactive approach towards the future in that it acknowledges that the future is open and may be shaped by today's' actions. In contrast to other policy formulation tools, foresight involves a bottom-up, interactive process with large participation and aims to mobilize joint actions. Therefore, the benefit of foresight can not only be seen in terms of its results but also in terms of its process bringing together various actors and helping to wire up the national innovation system.

There is no standard approach to foresight and foresight must be tailored to the needs of the individual country or case. This is why national foresight exercises vary greatly in rationale, objectives, scope and methodology used. Furthermore, foresight is an evolving process, so that now three generations of foresight activity can be identified. Another aspect of foresight is that it considers demand-pull and science and technology-push factors simultaneously in the identification of emerging technologies. Again, the point of balance depends on the individual case.

In Turkey, the role of science, technology and innovation in the welfare of the country is a well recognized fact and various efforts have been made thus far to benefit from this driver by formulating and implementing S&T policies from the 1960's onwards. However, the success in being able to formulate S&T policies was not equally shown in the implementation of these policies later on. The result is that the countries' standing in regard to science, technology and innovation is considered below a satisfactory level.

Turkey's most recent endeavor in science and technology policy formulation was the 'Vizyon 2023' project. The backbone of Vizyon 2023 is the technology foresight exercise, which constitutes the subject of this thesis. The aim of the Vizyon 2023 technology foresight project was to determine strategic technologies and priority areas of R&D and to formulate science and technology strategies for Turkey for the next 20 years.

Vizyon 2023 is based on a decision of the Supreme Council of Science and Technology, Turkey's foremost body of science and technology policy. The project was implemented by TÜBİTAK, the Scientific and Technical Research Council of Turkey and guided by a steering committee that comprised of representatives from governmental organizations, industrial organizations and NGOs, and universities.

The methodology adopted for the Turkish Technology Foresight involved socio-economic sector panels and a Delphi survey. Ten panels were formed on certain socio-economic fields and two others on cross cutting issues of 'education and human resources' and 'environment and sustainable development'. The panels made assessments of the general trends and the main drivers of change for their sectors, undertook a SWOT analysis and determined their vision and socio-economic goals and the technological activity topics and the underpinning technologies necessary to reach the socio-economic goals. The panels also prepared the Delphi statements for the Delphi survey, which was implemented in two rounds. The prioritization scheme of the Turkish foresight exercise is based on the five strategic technology criteria and their associated relative weights that had been decided by the steering committee. In the evaluation of the Delphi Survey results these criteria were used to compute an importance index for the each Delphi statement. A further index was developed to asses the feasibility of each Delphi statement. The Delphi Survey results were taken into consideration by the panels, but, the panels acted autonomously in determining their sectoral priorities and did not always adhere to the prioritization scheme based on the strategic technology criteria. After the completion of the panels' work and final reports, the project office synthesized the findings of the panels. This synthesis involves a vision for Turkey, a SWOT analysis, a compilation of socio-economic goals, and a compilation of technological activity topics and underpinning technologies. The result of the synthesis in terms of priority technologies is 65 technological activity topics and 8 strategic technology areas, whereby technological activity topics should be taken to represent demand-pull and strategic technology areas as science and technology-push effects. The foresight study continued by the formation of the strategic technology groups that prepared a report for each strategic technology including recommendations of how to gain competency in these areas.

The final step of the Turkish foresight was the preparation of the Vizyon 2023 strategy document that was finalized and presented to the BTYK. It is now Turkey's official S&T strategy in force. The Vizyon 2023 strategy document proposes a strategy that is based on focusing on the strategic technologies in a systemic coherence by selective funding and by motivation of research and education based on these strategic technologies. Forming networks of cooperation, developing the necessary human resources and creating awareness in all segments of society are pointed out as important strategic objectives. Public procurement and defense procurement based on R&D, a national R&D fund in conjunction with a national R&D program and guided R&D Projects are suggested as policy tools of preference.

The Turkish foresight exercise naturally has its strengths and weaknesses, as all such endeavors do and we have tried to identify these within this thesis. A major weakness of the exercise is its poor introduction to public opinion and the dissemination efforts later on. This can still be remedied by promoting the foresight and the resulting strategy as part of the efforts of creating S&T awareness in public. Another weakness we have highlighted was the difficulty to draw clear messages and directions from the foresight results. As a matter of fact, this is a weakness of many national foresight exercises. It would be beneficial to encourage studies on a cross-cutting level that examine the results of the foresight in terms of the technology lists, compare these with other countries findings to draw conclusions and recommend further policy advice and even propose specific projects to undertake.

In the Turkish case, we have considered its strong link to policy as strength. As the link to policy is important to the effect of a national foresight exercise on the countries' science, technology and innovation system, we have throughout this thesis followed the progress of the Vizyon 2023 project and the implementation of the new strategy by examining the BTYK decisions alongside the TÜBİTAK documentation. The result of this examination is that the BTYK decisions do actually support the results of the Vizyon 2023 project and pave the way for a successful implementation. Yet, we were led to the conclusion that this strong support does not guarantee successful implementation, since there are signs on the contrary. In particular, short term plans developed by the DPT are indicative of a starting divergence from the new S&T strategy.

A foresight study can be renewed and long term strategies can and should be revised in certain intervals of time. However, renewal efforts should not be in response to the different agendas and interests of different organizations, but to changing conditions and new developments. It is not possible to implement a nation-wide strategy without the commitment, positive collaboration, and coordination of all governmental organizations, the productive efforts of firms, NGO's, chambers of commerce and industry, public and private research institutes, universities etc. The success of the new S&T strategy will therefore depend on the degree at which this coordination is achieved.

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APPENDICES

APPENDIX A

THE PANEL AND STRATEGY GROUPS MEMBERS

Table A1: Information and Communication Panel Members

Member	Affiliation
Panel Leader	
Prof.Dr. Duran Leblebici	Işık Üniversitesi
Core Group Members	
Ali Akurgal (Secretary)	NETAŞ
Prof.Dr. Haluk Geray (Secretary)	TÜBİTAK-Proje Ofisi
Doç.Dr. Erbil Payzın (Secretary)	Payzın Danışmanlık Ltd. Şti.
Recep Çakal	DPT
Selim Sarper	Oksijen Teknoloji
Haluk Zontul	TÜBİTAK-BİLTEN
Panel Members	
Yücel Bağrıaçık	Türk Telekom A.Ş., Bilişim Ağları Dairesi
Suat Baysan	Cisco Systems
Tankut Beygu	Türk Telekom A.Ş., Bilişim Ağları Dairesi
Mustafa Dayanıklı	VEMUS
Alb.Kemal Dönmez	Milli Savunma Bakanlığı
Dicle Eroğul	Başarı Elektronik
Bülent Gönç	Koç Bilgi Grubu
Abdullah Raşit Gülhan	Telekomünikasyon Kurumu
Macit Güneş	Adam Elektronik
Prof. Dr. Halil Altay Güvenir	Bilkent Üniversitesi, Mühendislik Fakültesi, Bilgisayar Mühendisliği Bl.
İsmail Haznedar	Beko Elektronik A.Ş.
Dr. Asım Kepkep	İTÜ, Elektrik Elektronik Fakültesi
Altan Küçükçınar	BİLTEN-TÜBİTAK
Prof. Dr. Bülent Örencik	İTÜ, Bilgisayar Mühendisliği Bölümü
Prof.Dr. Atilla Özgit	ODTÜ, Bilgisayar Mühendisliği Bölümü
Murat Sarpel	VESTEL
Tuğrul Tekbulut	Logo LBS
Uran Tiryakioğlu	Beko Elektronik
Seyit Yıldırım	ASELSAN AŞ

Source: TÜBİTAK (2004c)

Table A2: Environment and Sustainable Development Panel Members

Member	Affiliation
Panel Leader	
Prof.Dr. Derin Orhon	İTÜ, İnşaat Fakültesi, Çevre Mühendisliği Bölümü
Core Group Members	
Prof.Dr. Seval Sözen (Secretary)	İTÜ, İnşaat Fakültesi, Çevre Mühendisliği Bölümü
Doç.Dr. Beyza Üstün (Secretary)	Yıldız Teknik Üniversitesi, İnşaat Fakültesi, Çevre Mühendisliği Bölümü
Ayhan Uysal (Secretary)	DPT, Yıllık Programlar ve Konjonktür Değerlendirme Genel Müdürlüğü
Doç.Dr.Erdem Görgün	TÜBİTAK-MAM, Enerji Sistemleri ve Çevre Araştırma Enstitüsü
Doç.Dr. Murat Türkeş	Devlet Meteroloji İşleri Genel Müdürlüğü, Araştırma ve Bilgi İşlem Dairesi
Oya Ersan	TÜBİTAK-Proje Ofisi
Panel Members	
Sema Alpan Atamer	Med Mühendislik ve Müşavirlik Ltd. Şti.
Güzin Arat	Çevre Bakanlığı, Çevre İstatistikleri Şubesi
Gülsevil Bahçeli	DİE
Sema Bayazıt	DPT, Sosyal Sektörler Koordinasyon Genel Müdürlüğü
Filiz Demirayak	Doğal Hayatı Koruma Derneği
Doç.Dr. Alper Güzel	ODTÜ, İktisat Bölümü
Dila Aksoy Hasan	Koç Grubu
Arş.Gör. Özlem Karahan Gül	İTÜ, İnşaat Fakültesi, Çevre Mühendisliği Bölümü
Dr. Merih Kerestecioğlu	Uluslararası Birleşmiş Müşavirler Müşavirlik Hizmetleri A.Ş.
Prof.Dr. Türkel Minibaş	İstanbul Üniversitesi, İktisat Fakültesi
Cezmi Neyim	ÇEVKO Vakfı
Dr. Erol Saner	AB Genel Sekreterliği
Prof.Dr. Yıldız Sey	İTÜ, Sosyal Bilimler Enstitüsü, Mimarlık Fakültesi
Yrd.Doç.Dr. Aysun Sofuoğlu	İzmir YüksekTeknoloji Enstitüsü, Kimya Mühendisliği Bölümü
Dr. Ethem Torunoğlu	Çevre Mühendisleri Odası
Dr. Caner Zanbak	Türkiye Kimya Sanayicileri Derneği

Source: TÜBİTAK (2004c)

Table A3: Education and Human Resources Panel Members

Member	Affiliation
Panel Leader	
Prof.Dr. İhsan Sezal	Gazi Üniversitesi Gazi Eğitim Fakültesi
Core Group Members	
Yrd.Doç.Dr.İ.Soner Yıldırım (Secretary)	ODTÜ, Eğitim Fakültesi
Dr. Ali Kozbek (Secretary)	Milli Eğitim Bakanlığı
Prof. Dr. Hamit Serbest (Secretary)	Çukurova Üniversitesi, Mühendislik Mimarlık Fakültesi
Hüseyin Coşkun (Secretary)	Devlet Planlama Teşkilatı
Mehmet Kılıç	TÜBİTAK-Proje Ofisi
Panel Members	
Prof. Dr. Nabi Avcı	İstanbul Bilgi Üniversitesi, İletişim Fakültesi
Hakan Arslan	
Kadir Bayraktar	Ankara Sanayi Odası
Prof.Dr. Hüsnü Erkan	Dokuz Eylül Üniversitesi, İktisadi İdari Bilimler Fakültesi
Doç.Dr. Semra Erkan	Hacettepe Üniversitesi, Eğitim Bilimleri Fakültesi
Doç.Dr. İrfan Erdoğan	İstanbul Üniversitesi, Eğitim Bilimleri Fakültesi
Dr. Şeref Hoşgör	Devlet İstatistik Enstitüsü Başkanlığı
Prof. Dr. Mustafa İsen	Başkent Üniversitesi, Türk Dili ve Edebiyatı Bölümü
Dr. Öner Kabasakal	
Yrd. Doç. Dr.Hasan Bülent Kahraman	Sabancı Üniversitesi, Sanat ve Sosyal Bilimler Fakültesi
Prof. Dr.Fersun Paykoç	ODTÜ, Eğitim Fakültesi, Eğitim Bilimleri Bölümü
Doç. Dr. Öğ. Alb. Kadir Varoğlu	Kara Harp Okulu, Savunma Bilimleri Enstitü Müdürlüğü

Source :TÜBİTAK (2004c)

Table A4: Energy and Natural Resources Panel Members

Member	Affiliation
Panel Leader	
Prof Dr. R. Nejat Tuncay	İTÜ, Elektrik-Elektronik Fakültesi, Elektrik Mühendisliği Bölümü
Core Group Members	
Prof.Dr. Vural Altın (Secretary)	Boğaziçi Üniversitesi, Nükleer Mühendislik ABD
Dr. Filiz Çimen	TÜBİTAK-Proje Ofisi
Panel Members	
Ali Alat	TAEK
Prof. Dr. Ahmet Arısoy	İTÜ, Makina Fakültesi
Nazım Bayraktar	Enerji Piyasası Düzenleme Kurulu
Prof.Dr. Taner Derbentli	İTÜ, Makine Fakültesi
Prof.Dr. Nilüfer Eğrican	Yeditepe Üniversitesi, Muhendislik-Mimarlik Fak., Makine Muhendisliği Bl.
Prof. Dr. Sıddık İçli	Ege Üniversitesi, Güneş Enerjisi Enstitüsü Müdürlüğü
Prof. Dr. Demir İnan	Temiz Enerji Vakfı
Kubilay Kavak	DPT
Prof.Dr. Adnan Kaypmaz	İTÜ, Elektrik-Elektronik Fakültesi
Tülin Keskin	Elektrik İşleri Etüt İdaresi Genel Müdürlüğü
Hv.Y.Müh.Yrb. Kemal Kıran	MSB, Ar-Ge ve Teknoloji Daire Başkanlığı
Prof.Dr. Hüseyin Oğuz	Ankara Üniversitesi, Mühendislik Fakültesi, Kimya Mühendisliği Bölümü
Prof.Dr. Hasancan Okutan	İTÜ, Kimya-Metalurji Fakültesi
Prof.Dr. Sermin Onaygil	İTÜ, Enerji Enstitüsü Enerji Planlaması ve Yönetimi ABD
Pınar Özel	DPT
Hanife Özkan	Enerji ve Tabii Kaynaklar Bakanlığı, APK Kurulu Başkanlığı
Prof.Dr. Nevin Selçuk	ODTÜ, Kimya Mühendisliği Bölümü
Doç. Dr. Mustafa Tırıs	TÜBİTAK MAM
Selva Tüzüner	Elektrik Üretim A.Ş. Genel Müdürlüğü

Source:TÜBİTAK (2004c)

Table A5: Construction and Infrastructure Panel Members

Member	Affiliation
Panel Leader	
Sezer Ergin	DAP Danışmanlık
Core Group Members	
Prof.Dr. Murat Balamir (Secretary)	ODTÜ, Mimarlık Fakültesi
Prof. Dr. Kutay Özaydın (Secretary)	Yıldız Teknik Üniversitesi, İnşaat Fakültesi
Ender Arkun	TÜBİTAK-Proje Ofisi
Panel Members	
Alp Acar	ER-KA A.Ş
Emrah Acar	İTÜ, Mimarlık Fakültesi, Mimarlık Bölümü
Hanefi Arabacı	Tepe Mobilya Genel Müdürlüğü
Nazım Avcı	Bayındırlık Bakanlığı, Yapı İşleri Genel Müdürlüğü
Alp Erdem	DİE, İnşaat İstatistikleri Şubesi
Burhan Evcil	Bursa Çimento Fabrikası
Doğan Hasol	Yapı Endüstri Merkezi
İrfan Karaoğlu	Başarı Yatırımlar A.Ş.
Soner Kozan	
Prof.Dr. Mustafa Pultar	Bilkent Üniversitesi, Güzel Sanatlar, Mimarlık ve Tasarım Fakültesi
Prof.Dr. Tuğrul Tankut	ODTÜ, İnşaat Mühendisliği Bölümü
Ruhi Tarkan	Müteahhitler Birliği
Mehmet Uzunkaya	DPT
Doğan Yemişen	DSİ
Haluk Yılmaz	Çevre Bakanlığı, ÇED ve Planlama Genel Müdürlüğü

Source: TÜBİTAK (2004c)

Table A6: Chemicals Panel Members

Member	Affiliation
Panel Leader	
Refik Önür	AKKİM
Core Group Members	
Prof.Dr.Birgül Tantekin Ersolmaz (Secretary)	İTÜ, Kimya-Metalurji Fakültesi Kimya Mühendisliği Bölümü
Doç.Dr. Deniz Üner (Secretary)	ODTÜ, Kimya Mühendisliği Bölümü
Dr. Talat Çiftçi	Hakan Madencilik
Ayşegül Yılmaz	TÜBİTAK-Proje Ofisi
Panel Members	
Naim Alemdaroğlu	INSA, İstanbul Naylon Sanayi A.Ş.
Emine Aygören	DPT
Yasemin Başar	ŞİŞECAM, Kimyasallar Grubu
Alber Bilen	Türkiye Kimya Sanayicileri Derneği
Nilüfer Düzgören	PETKİM
Timur Erk	Türkiye Kimya Sanayicileri Derneği
Hakan Ersin	Siemens Industrial Solutions & Services
Eyüp Ertürk	ŞİŞECAM, Kimyasallar Grubu
Ünay Güldal	ŞİŞECAM, Kimyasallar Grubu
Prof.Dr. Ersan Kalafatoğlu	Marmara Üniversitesi, Mühendislik Fakültesi
Mehmet Hayati Öztürk	PETKİM
Prof. Dr. M Sümer Peker	Ege Üniversitesi, Kimya Mühendisliği Bölümü
Mustafa Yılmaz	AKSA Akrilik Kimya Sanayii A.Ş.

Source: TÜBİTAK (2004c)

Table A7: Machinery and Materials Panel Members

Member	Affiliation
Panel Leader	
Refik Üreyen	İTÜ, Fen Bilimleri Enstitüsü
Core Group Members	
Dr. Baha Kuban (Secretary)	ŞİŞECAM
İffet İyigün Meydanlı (Secretary)	ARÇELİK
Verda Yunusoğlu (Secretary)	Sabancı Üniversitesi, Araştırma ve Lisansüstü Politikaları
Mehmet Kılıç	TÜBİTAK-Proje Ofisi
Panel Members	
Tülay Akarsoy Altay	TÜBİTAK-TİDEB
Hakan Altınay	Kale Altınay Robotik ve Otomasyon
Ali Attila Arsan	İntersonik
Doç. Dr. Tarık Baykara	TÜBİTAK-MAM
Ahmet Bayraktar	Bayraktarlar Holding
Atilla Bedir	DPT
Barbaros Demirci	TAYSAD
Hülya Ercan	Otomotiv Sanayii Derneği
Emin Gök	
M. Akif Koca	DPT, İktisadi Sektörler ve Koordinasyan Genel Müdürlüğü
Şeref Saygılı	Bankacılık Denetleme ve Düzenleme Kurumu
Doc. Dr. M.Yalçın Tanes	ARÇELİK
Prof.Dr. Ercan Tezer	Otomotiv Sanayi Derneği
Yusuf A.Uskaner	Özçelik A.Ş.
Enver Ünal	Asmaç Ağır Sanayi Makinalar
Alb. Hüseyin Yatır	MSB, Ar-Ge ve Teknoloji Daire Başkanlığı
Yusuf Yel	Unimac Makina Sanayi ve Ticaret A.Ş.
Murat Yıldırım	FORD

Source: TÜBİTAK (2004c)

Table A8: Health and Pharmaceuticals Panel Members

Member	Affiliation
Panel Leader	
Prof.Dr. Yücel Kanpolat	Ankara Üniversitesi, Tıp Fakültesi
Core Group Members	
Prof.Dr.Yusuf Serdar Akyar (Medical Equipment, Tools and Materials Group Leader)	Ankara Üniversitesi, Tıp Fakültesi
Haldun Özdemir (Medical Equipment, Tools and Materials Group Secretary)	MEDİSPO Ltd.Şti.
Prof.Dr. İlker Kanzık (Pharmaceuticals Group Leader)	Gazi Üniversitesi, Eczacılık Fakültesi, Farmakoloji A.B.D.
Prof.Dr. Erdal Akalın (Pharmaceuticals Group Secretary)	Pfizer İlaçları Ltd. Şti.
Prof.Dr. Zafer Öztek (Medical ServicesGroup Leader)	Hacette Ünversitesi, Tıp Fakültesi, Halk Sağlığı Anabilim Dalı
Dr.Osman Toprak (Medical Services Group Secretary)	Sağlık Bakanlığı
Doç.Dr. Ali Savaş (Panel Secretary)	Ankara Üniversitesi, Tıp Fakültesi
Mustafa Ay	TÜBİTAK-Proje Ofisi
Panel Members	
Prof.Dr. Umut Akyol	Hacettepe Ünversitesi, Tıp Fakültesi
Emine Aygören	DPT
Rıdvan Bıçakçı	Bıçakçılar Tıbbi Cihazlar A.Ş.
Sedat Birol	Eczacıbaşı İlaç Sanayi ve Ticarcet A.Ş.
Prof.Dr. Doğan Bor	Ankara Üniversitesi, Fen Fakültesi, Fizik Bölümü
Prof.Dr. Beyazıt Çırakoğlu	Marmara Üniversitesi Tıp Fakültesi
Yrb. Ertan Halaç	GATA Komutanlığı, BKMM Başkanlığı
Prof.Dr. Ali Esat Karakaya	Gazi Üniversitesi, Eczacılık Fakültesi
Yrd.Doç.Dr. Erkan Mumcuoğlu	ODTÜ, Enformatik Enstitüsü
Prof.Dr. Muhit Özcan	Ankara Üniversitesi, Tıp Fakültesi. Hematoloji A.B.D.
Yücel Özkök	Serbest
Pelin Tekneci	DPT
Kaya Turgut	Fako İlaçları A.Ş.
Nurettin Turan	Fako İlaçları A.Ş.
Yrd.Doç. Dr.Cengiz Yakıcıer	Bilkent Üniversitesi, Moleküler Biyoloji ve Genetik Bölümü

Source: TÜBİTAK (2004c)

Table A9: Aeronautics, Defense and Space Industry Panel Members

Member	**Affiliation**
Panel Leader	
Aytekin Ziylan	Emekli Mu. Tuğgeneral
Core Group Members	
Yzb. Refik Altay (Secretary)	GENELKURMAY BİLKARDEM Başkanlığı
Mehmet Zaim (Secretary)	ASELSAN
Raşit Por	TÜBİTAK - MAM
Elif Baktır	ASELSAN
Ayşegül Yılmaz	TÜBİTAK-Proje Ofisi
Panel Members	
Prof.Dr. Nafiz Alemdaroğlu	ODTÜ, Havacılık ve Uzay Mühendisliği Bölümü
Prof. Dr. Ömer Anlağan	TÜBİTAK-SAGE
Öğ. Kd.Alb. Turan Aral	GENELKURMAY BİLKARDEM Başkanlığı, Proje Genel Koordinatörlüğü
Şemsi Batmaca	ASELSAN
Alb. Necip Baykal	MSB, Ar-Ge ve Teknoloji Dairesi Başkanlığı
Prof. Dr. Cahit Çıray	ODTÜ, Havacılık ve Uzay Mühendisliği Bölümü
İbrahim Demir	DPT, İktisadi Sektörler ve Koordinasyan Genel Müdürlüğü
Muharrem Dörtkaşlı	TUSAŞ
Yavuz Göker	GENELKURMAY BAŞKANLIĞI-Hava Kuvvetleri Komutanlığı
Sedat Güldoğan	Savunma Sanayii Müsteşarlığı
Dr.Yük.Müh.Alb.T.Yaşar Katırcıoğlu	MSB, Ar-Ge ve Teknoloji Dairesi Başkanlığı
Prof. Dr. Mehmet Kıcıman	ODTÜ, Mühendislik Bilimleri Bölümü
Cem Özenen	DPT, İktisadi Sektörler ve Koordinasyan Genel Müdürlüğü
Prof.Dr.Yurdanur Tulunay	İTÜ, Uçak ve Uzay Bilimleri Fakültesi, Uzay Mühendisliği Bölümü
Bnb. Nevzat Ünalan	GENELKURMAY BİLKARDEM Başkanlığı

Source: TÜBİTAK (2004c)

Table A10: Agriculture and Food Panel Members

Member	Affiliation
Panel Leader	
Prof.Dr. Sabit Ağaoğlu	Ankara Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü
Core Group Members	
Prof.Dr. Muharrem Certel (Secretary)	Akdeniz Üniversitesi, Ziraat Fakültesi, Gıda Mühendisliği Bölümü
Dr. Vehbi Eser (Secretary)	Tarımsal Araştırmalar Genel Müdürlüğü
Prof.Dr. Musa Sarıca (Secretary)	Ondokuz Mayıs Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü
Prof.Dr. Neşet Kılınçer	TÜBİTAK-TOGTAG
Doç.Dr. Filiz Ayanoğlu	TUBİTAK-Proje Ofisi
Panel Members	
Prof.Dr. Neşet Arslan	Ankara Üniversitesi, Ziraat Fakültesi, Tarla Bitkileri Bölümü
Prof. Dr. Nevzat Artık	Ankara Üniversitesi, Ziraat Fakültesi, Gıda Mühendisliği Bölümü
Doç. Dr. Hüseyin Basım	Akdeniz Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü
Prof.Dr. Recep Bircan	Ondokuz Mayıs Üniversitesi, Sinop Su Ürünleri Fakültesi
Prof Dr. Melih Boydak	İstanbul Üniversitesi, Orman Fakültesi
Doç.Dr. Yücel Çağlar	Milli Prodüktivite Merkezi
Nebi Çelik	DPT
Prof. Dr. Selim Çetiner	Sabancı Üniversitesi, Doğa Bilimleri Fakültesi
Prof. Dr. İbrahim Demir	Ankara Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü
Kemal Erdoğan	Cine-Tarım
Olgun Ergüz	Yaşar Holding A.Ş
Ülkü Karakuş	Türkiye Yem Sanayicileri Birliği
Doç. Dr. Mehmet Kuran	Ondokuz Mayıs Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü
Prof. Dr. Ahmet Özçelik	Ankara Üniversitesi, Ziraat Fakültesi, Tarım Ekonomisi Bölümü
Dr. Muhteşem Torun	Tarımsal Araştırmalar Genel Müdürlüğü

Source: TÜBİTAK (2004c)

Table A11: Textiles Panel Members

Member	Affiliation
Panel Leader	
Mehmet Şuhubi	Paxar-Teslo Tekstil Ürün Sanayi Ticaret A.Ş.
Core Group Members	
Levent Ataünal (Secretary)	Picanol
Demir Fansa (Secreatry)	MCV Yönetim Danışmanlığı
Işık Erten	TÜBİTAK-Proje Ofisi
Panel Members	
Atilla Tamer Alptekin	Karsu Tekstil Genel Müdürlüğü
Selçuk Ataman	Esas Holding
Dr. Bülent Atuk	Ceylan Giyim
Reha Erekli	İstanbul Hazır Giyim ve Konfeksiyon İhracatçıları Birliği
Kamil Kasacı	Lena Tekstil Sanayi Ticaret Ltd.
Dr. Güngör Keşçi	TGSD/Gals Tekstil Konfeksiyon Endüstri Ticaret A.Ş
Ataman Onar	Akdeniz Tekstil
Umut Oran	Domino Tekstil
Emrah Öngüt	DPT
Prof. Dr. Bülent Özipek	İTÜ, Tekstil Mühendisliği Bölümü
Zafer Parlar	Nike
Prof. Dr. Işık Tarakçıoğlu	Ege Üniversitesi Tekstil ve Konfeksiyon Uygulama Merkezi

Source: TÜBİTAK (2004c)

Table A12: Transportation and Tourism Panel Members

Member	Affiliation
Panel Leader	
Süreyya Yücel Özden	GAMA
Core Group Members	
Tolga Akgün (Secreatry)	
Nazif Ekzen (Secreatry)	Anka Ajansı
Hüseyin Akova	TÜBİTAK-Proje Ofisi
Panel Members	
Ali Ağbal	Turizm Bakanlığı, Kültür ve Yatırım ve İşletmeler Genel Müdürlüğü
Seçim Aydın	TÜROB
Nermin Bahadır	Hazine Müsteşarlığı
Dr. İbrahim Birkan	TURSER
Oktay Erdağı	Ulaştırma Bakanlığı, Sivil Havacılık Genel Müdürlüğü
Yücel Erdem	Yollar Türk Milli Komitesi
Mustafa Fırat	Ulaştırma Bakanlığı, APK Kurulu Başkanlığı
Şükrü Gümüş	T.C.D.D. Genel Müdürlüğü, Tesisler Daire Başkanlığı
Haluk Işındağ	IŞIN Sanayi Danışmanlık
Hülya Örs	DPT
Hülya Tokgöz	DPT
M. Nusret Yarıkkaş	

Source: TÜBİTAK (2004c)

Table A13: Information and Communication Technologies Strategy Group Members

Member	Affiliation
Coordinator	
Prof.Dr. Duran Leblebici	Işık Üniversitesi
Members	
Ali Akurgal	NETAŞ
Prof.Dr. Haluk Geray	TÜBİTAK
Doç.Dr. Erbil Payzın	Payzın Danışmanlık Ltd. Şti
Selim Sarper	ARGELA Teknoloji

Source: TÜBİTAK (2004c)

Table A14: Design Technologies Strategy Group Members

Member	Affiliation
Coordinator	
Doç.Dr. Serdar Çelebi	İTÜ, Bilişim Enstitüsü
Secretaries	
Ömer Hakan Okutan	Arçelik, Çamaşır Makinesi İşletmesi
Ayşegül Yılmaz	TÜBİTAK, BTP
Members	
Ömer Akbaş	Arçelik, ARGE
Elif Baktır	ASELSAN MST Grubu
Prof.Dr. Sedat Bayseç	Gaziantep Üniversitesi, Makine Mühendisliği Bölümü
Refik Diri	Karel Kalıp A.Ş.
Prof.Dr. Abdülkerim Kar	Marmara Üniversitesi, Mühendislik Fakültesi, Makina Bölümü
Burak Kıray	Ford Otosan
Aydın Kuntay	Bias
Uğur Oksay	ETA A.Ş.
Dr. Tarık Öğüt	FİGES Ltd.Şti.
Burak Pekcan	İnfo-Tron A.Ş.
Uğur Sarıbay	SATEK
Tuğrul Tekbulut	Logo LBS
Refik Üreyen	TTGV, Danışman

Source: TÜBİTAK (2004c)

Table A15: Biotechnology and Gene Technologies Strategy Group Members

Member	Affiliation
Coordinator and Health Subgroup Secretary	
Prof.Dr. Mehmet Öztürk	Bilkent Üniversitesi, Fen Fakültesi, Moleküler Biyoloji ve Genetik ABD
Agriculture Subgroup Secretary	
Prof.Dr. İsmail Çakmak	Sabancı Üniversitesi
Stockbreeding Subgroup Secretary	
Doç.Dr. Sezen Arat	TÜBİTAK-MAM-GMBAE
Industrial Production Subgroup Secretary	
Prof.Dr. Haluk Hamamcı	ODTÜ, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü
Members	
Prof.Dr.Mahinur Akkaya	ODTÜ
Doç.Dr. Ender Altıok	Acıbadem Hastanesi, Genetik Tanı Merkezi
Prof.Dr. Neşe Atabey	Dokuz Eylül Üniversitesi, Tıp Fakültesi, Tıbbi Biyoloji ve Genetik ABD
Doç.Dr. Haydar Bağış	TÜBİTAK-MAM-GMBAE
Prof.Dr. Neşe Bilgin	Boğaziçi Üniversitesi, Moleküler Biyoloji ve Genetik Bölümü
Prof.Dr. İhsan Çalış	Hacettepe Üniversitesi, Eczacılık Fakültesi,Farmakognozi ABD
Prof.Dr. Selim Çetiner	Sabancı Üniversitesi, Doğa Bilimleri Fakültesi
Yrd.Doç.Dr. Sami Doğanlar	İzmir Yüksek Teknoloji Enstitütüsü, Biyoloji Bölümü
Prof.Dr. Sedat Dönmez	Ankara Üniversitesi, Ziraat Fakültesi, Gıda Mühendisliği Bölümü
Prof.Dr. Türkan Eldem	Hacettepe Üniversitesi, Eczacılık Fakültesi,Farmasötik Biyoteknoloji ABD
Prof.Dr. Burak Erman	Koç Üniversitesi, Kimya ve Biyoloji Mühendisliği Bölümü
Prof.Dr. Okan Ertuğrul	Ankara Üniversitesi, Veterinerlik Fakültesi, Genetik ABD
Doç.Dr. İsmet Gürhan	Ege Üniversitesi, Biyomühendislik Bölümü
Prof.Dr. Nesrin Hasırcı	ODTÜ, Fen Edebiyat Fakültesi, Kimya Bölümü
Doç.Dr. Dilek Kazan	TÜBİTAK-MAM-GMBAE
Dr. Ercan Kurar	Selçuk Üniversitesi, Veterinerlik Fakültesi, Zooteknigenetik Bölümü
Prof.Dr. H.Avni Öktem	ODTÜ, Biyoloji Bölümü
Prof.Dr. Meral Özgüç	Hacettepe Üniversitesi, Tıp Fakültesi, Tıbbi Biyoloji ABD
Prof.Dr. Zehra Sayers	Sabancı Üniversitesi, Mühendislik ve Doğa Bilimleri Fakültesi
Dr. Uğur Sezerman	Sabanci Üniversitesi
Dr. Tijen Talas	TÜBİTAK-MAM-GMBAE

Source: TÜBİTAK (2004c)

Table A16: Energy and EnvironmentTechnologies Strategy Group Members

Member	**Affiliation**
Coordinator	
Prof.Dr. Nejat Tuncay	İTÜ, Elektrik-Elektronik Fakültesi,Elektrik Mühendisliği Bölümü
Energy Subgroup Secretary	
Doç. Dr. Hayati Olgun	TÜBİTAK-MAM-ESÇAE
Prof.Dr. Sermin Onaygil	İTÜ, Enerji Enstitüsü
Environment Subgroup Secretary	
Oya Ersan	TÜBİTAK-İÇTAG
Members	
Ali Alat	Türkiye Atom Enerjisi Kurumu
Doç.Dr. Kadir Alp	İTÜ, İnşaat Fakültesi, Çevre Mühendisliği Bölümü
Prof.Dr. Vural Altın	
Prof.Dr. Ahmet Arısoy	İTÜ, Makina Fakültesi
Prof.Dr. Hüsnü Atakül	İTÜ, Kimya-Metalurji Fakültesi
Dr. Ahmet Baban	TÜBİTAK-MAM-ESÇAE
Doç.Dr. Işıl Balcıoğlu	Boğaziçi Üniversitesi, Çevre Bilimleri Enstitüsü
Dr. Müfide Banar	Anadolu Üniversitesi, Mühendislik Mimarlık Fakültesi,Çevre Müh. Bl.
Prof.Dr. Taner Derbentli	İTÜ, Makina Fakültesi
Y. Mühendis Özgür Doğan	TÜBİTAK-MAM-ESÇAE
Prof.Dr. Nilüfer Eğrican	Yeditepe Üniversitesi, Muhendislik ve Mimarlik Fakultesi,Makine Müh. Bl.
Doç.Dr. Ayşen Erdinçler	Boğaziçi Üniversitesi, Çevre Bilimleri Enstitüsü
Prof. Dr. Ayşegül Ersoy - Meriçboyu	İTÜ, Kimya Metalurji Fakültesi, Kimya Mühendisliği Bölümü
Dr. Atilla Ersöz	TÜBİTAK-MAM-ESÇAE
Prof.Dr. Sıddık İçli	Ege Üniversitesi, Güneş Enerjisi Enstütisü Müdürü
Prof.Dr. Selahattin İncecik	İTU, Uçak ve Uzay Bilimleri Fakültesi, Meteoroloji Mühendisliği Bölümü
Prof.Dr. Adnan Kaypmaz	İTÜ, Elektrik-Elektronik Fakültesi, Elektrik Mühendisliği Bölümü
Prof.Dr. Hasancan Okutan	İTÜ, Kimya-Metalurji Fakültesi Dekanı
Dr. Erol Saner	AB Genel Sekreterliği
Doç.Dr. Beyza Üstün	Yıldız Teknik Üniversitesi, Çevre Mühendisliği Bölümü

Source: TÜBİTAK (2004c)

Table A17: Nanotechnology Strategy Group Members

Member	**Affiliation**
Coordinator	
Prof.Dr. Salim Çıracı	Bilkent Üniversitesi, Fen Fakültesi, Fizik Bölümü
Secretary	
Dr. Oğuz Gülseren	Bilkent Üniversitesi, Fen Fakültesi, Fizik Bölümü
Members	
Prof.Dr.Engin Akkaya	ODTÜ, Fen Edebiyat Fakültesi, Kimya Bölümü
Prof.Dr. Sahir Arıkan	ODTÜ, Mühendislik Fakültesi, Makine Mühendisliği Bölümü
Prof.Dr. Ömer Dağ	Bilkent Üniversitesi, Fen Fakültesi, Kimya Bölümü
Prof.Dr. Şakir Erkoç	ODTÜ, Fen Edebiyat Fakültesi, Fizik Bölümü
Prof.Dr. Tuğrul Hakioğlu	Bilkent Üniversitesi, Fen Fakültesi, Fizik Bölümü
Prof.Dr. Ahmet Oral	Bilkent Üniversitesi, Fen Fakültesi, Fizik Bölümü
Prof.Dr. Ekmel Özbay	Bilkent Üniversitesi, Fen Fakültesi, Fizik Bölümü
Prof.Dr. Macit Özenbaş	ODTÜ, Mühendislik Fakültesi, Metalurji ve Malzeme Müh. Bölümü
Prof.Dr. Mehmet Öztürk	Bilkent Üniversitesi, Moleküler Biyoloji ve Genetik ABD
Prof.Dr. Erhan Pişkin	Hacettepe Üniversitesi, Mühendislik Fakültesi, Kimya Müh. Bölümü
Prof.Dr. Raşit Turan	ODTÜ, Fen Edebiyat Fakültesi, Fizik Bölümü

Source: TÜBİTAK (2004c)

Table A18: Mechatronics Strategy Group Members

Member	Affiliation
Coordinator	
Prof.Dr. Aydan Erkmen	ODTÜ, Mühendislik Fakültesi, Elektrik-Elektronik Mühendisliği Bölümü
MEMS and Sensors Subgroup Secretary	
Prof.Dr. Tayfun Akın	ODTÜ, Mühendislik Fakültesi, Elektrik-Elektronik Mühendisliği Bölümü
Robotics and Automation Technologies Subgroup Secretary	
Hakan Altınay	Kale Altınay Robotik ve Otomasyon
Generic Areas Subgroup Secretary	
Prof.Dr. Ahmet Kuzucu	İTÜ, Makina Fakültesi, Makine Mühendisliği Bölümü
Members	
Prof.Dr. Abdülkadir Erden	Atılım Üniversitesi, Mekatronik Mühendisliği Bölümü
Prof.Dr. İsmet Erkmen	ODTÜ, Mühendislik Fakültesi, Elektrik-Elektronik Mühendisliği Bölümü
Yrd.Doç.Dr. Şeniz Ertuğrul	İTÜ, Makine Fakültesi
Doç.Dr. Yaşar Gürbüz	Sabancı Üniversitesi
Prof.Dr. Levent Güvenç	İTÜ, Makina Fakültesi, Tekstil Mühendisliği Bölümü
Prof.Dr. Gürkan Karakaş	ODTÜ, Mühendislik Fakültesi, Kimya Mühendisliği Bölümü
Prof.Dr. Zafer Ziya Öztürk	Gebze Yüksek Teknoloji Enstitüsü, Fen Fakültesi, Fizik Bölümü
Yrd.Doç.Dr. Levent Trabzon	İTÜ, Makina Fakültesi
Yrd.Doç.Dr. Hakan Ürey	Koç Üniversitesi, Makina Mühendisliği Bölüm
Seyit Yıldırım	ASELSAN MST Grubu

Source: TÜBİTAK (2004c)

Table A19: Production Processes and Systems Strategy Group Members

Member	Affiliation
Coordinator	
Refik Üreyen	TTGV, Danışman
Members	
Naim Alemdaroğlu	İstanbul Naylon Sanayi A.Ş.
Tülay Altay Akarsoy	TÜBİTAK-TİDEB
Hakan Altınay	Kale Altınay
Levent Ataünal	GTP
Prof.Dr. Ali Fuat Çakır	İTÜ, Kimya Metalurji Fakültesi, Metalurji ve Malzeme Müh. Bölümü
Ferhat Erçetin	ARÇELİK A.Ş.
Timur Erk	Türkiye Kimya Sanayicileri Derneği
Prof.Dr. Birgül Ersolmaz Tantekin	İTÜ, Kimya-Metalurji Fakültesi, Kimya Mühendisliği Bölümü
Mustafa Esenlik	ARÇELİK A.Ş.
Doç.Dr. İsmail Lazoğlu	Koç Üniversitesi, Makine Mühendisliği Bölümü
Yrd.Doç.Dr. Haydar Livatyalı	İTÜ Makina Fakültesi, Makina Mühendisliği Bölümü
Prof.Dr. Turgut Tümer	ODTÜ, Mühendislik Fakültesi, Makine Mühendisliği Bölümü
Doç.Dr. Deniz Üner	ODTÜ, Kimya Mühendisliği Bölümü
Mustafa Ürgen	İTÜ, Kimya Metalurji Fakültesi, Metalurji ve Malzeme Mühendisliği
Bölümü Murat Yıldırım.	FORD Otosan A.Ş

Source: TÜBİTAK (2004c)

Table A20: Materials Technologies Strategy Group Members

Member	**Affiliation**
Coordinator	
Doç.Dr. Tarık Baykara	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Members	
Prof.Dr. Kerim Allahverdi	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Gamze Avcı	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Dr. Tahsin Bahar	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Doç.Dr. Şerafettin Eroğlu	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Doç.Dr. Volkan Günay	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Dr. Mehmet Güneş	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Dr. Baha Kuban	Türkiye Şişe ve Cam Fabrikaları A.Ş.
Doç.Dr. Emel Musluoğlu	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Dr. Elif Tahtasakal	MAM Malzeme ve Kimya Teknolojileri Enstitüsü
Refik Üreyen	TTGV, Danışman

Source: TÜBİTAK (2004c)

Table A21: Education and Human Resources Strategy Group Members

Member	Affiliation
Coordinator	
Prof.Dr. Hamit Serbest	Çukurova Üniversitesi, Mühendislik Mimarlık Fakültesi
Secretaries	
Prof.Dr. İsmail Bircan	İzmir Ekonomi Üniversitesi, Genel Sekreterliği
Prof.Dr. Hüsnü Erkan	Dokuz Eylül Üniversitesi, İktisadi İdari Bilimler Fakültesi
Dr. Ali Kozbek	
Doç.Dr. Erbil Payzın	Payzın Danışmanlık Ltd. Şti.
Yrd.Doç.Dr. Soner Yıldırım	ODTÜ, Eğitim Fakültesi
Members	
Prof.Dr. Petek Aşkar	Hacettepe Üniversitesi, Eğitim Fakültesi
Batuhan Aydagül	Sabancı Üniversitesi
Erbil Cihangir	İTKİB, İstanbul Tekstil ve Konfeksiyon İhracatçı Birlikleri
Prof.Dr. Mehmet Demirkol	İTÜ, Makina Fakültesi Dekanı
Prof.Dr. Nilüfer Eğrican	Yeditepe Üniversitesi Mühendislik ve Mimarlik Fakultesi
Savaş Erişen	Mesleki Eğitim ve Küçük Sanayii Destekleme Vakfı
Ruhi Esirgen	
Murat Gürkan	MEB-METARGEM
Dr. Şeref Hoşgör	Başkent Üniversitesi
Prof.Dr. A. Rıza Kaylan	Boğaziçi Üniversitesi Mühendislik Fakültesi Dekanı
Dr. Ruhi Kılıç	MEB-METARGEM
Dr. İrfan Mısırlı	ARC Uluslararası Danışmanlık Eğitim ve Bilişim Hizmetleri A.Ş.
Prof.Dr.Fersun Paykoç	ODTÜ, Eğitim Fakültesi Eğitim Bilimleri Bölümü
Prof.Dr. Bülent Emre Platin	ODTÜ, Mühendislik Fakültesi

Source: TÜBİTAK (2004c)

APPENDIX B

THE DELPHI STATEMENTS

Table B1: The First 5 Delphi Statements With Respect To Researcher Potential

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
114	Development of horizontal and vertical road marking technologies that determine the average velocity and flow rate of traffic and transfer this data to a center.	2.33
180	Promotion and usage of advanced purification technologies for the elimination of nitrogen and phosphorus in wastewater discharge in critical areas.	2.32
113	Development of advanced material technologies in horizontal and vertical marking of transportation infrastructures.	2.29
170	Increasing the usability of purification sludge as construction and filling material.	2.28
108	Wide-spread usage of technologies that are suitable to combined transportation and enable the continuous tracking of loads in electronic form.	2.24

Source: TÜBİTAK (2004b, p. 20)

Table B2: The Last 5 Delphi Statements With Respect To Researcher Potential

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
227	The production of OLED (organic LED) monitors to reach 50 % of annual monitor production.	1,07
235	Large memory virtual reality eyeglasses with wireless data communication capability to be used in assembly and maintenance of complex mechanisms in industrial and service applications.	1,06
23	The number of organic integrated circuits used in one year to reach 10% of the total semiconductor integrated circuit number.	1,00
96	Development of unmanned under-water construction machinery.	1,00
238	Manufacturing of lithography machines with sub-100nm precision.	1,00

Source: TÜBİTAK (2004b, p. 21)

Table B3: The First 5 Delphi Statements With Respect To R&D Infrastructure

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
110	Wide-spread usage of SCADA systems for the detection and processing of data related to fire hazard, air pollution and security in tunnels.	2.08
113	Development of advanced material technologies for horizontal and vertical marking of the transportation infrastructure.	2.07
114	Development of horizontal and vertical road marking technologies that determine the average velocity and flow rate of traffic and transfer this data to a center.	2.07
34	Use of personal computers with internet connection instead of ballot boxes in election centers for parliamentary and municipal elections.	2.02
112	The wide-spread use of RFID (Radiofrequency Identification systems) in all access control systems.	2.00

Source: TÜBİTAK (2004b, p. 24)

Table B4: The Last 5 Delphi Statements With Respect To R&D Infrastructure

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
235	Large memory virtual reality eyeglasses with wireless data communication capability to be used in assembly and maintenance of complex mechanisms in industrial and service applications.	0.75
238	Manufacturing of lithography machines with sub-100nm precision.	0.75
239	Production of ultra-precision, adjustable engineering machinery using nanotechnological materials.	0.72
258	Development of systems which detect and process the bio-energy emitted by humans.	0.67
96	Development of unmanned under-water construction machinery.	0.60

Source: TÜBİTAK (2004b, pp. 25-26)

Table B5: The First 5 Delphi Statements With Respect To Competency in Basic Science

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
180	Promotion and usage of advanced purification technologies for the elimination of nitrogen and phosphorus in wastewater discharge in critical areas.	2.49
189	Wide-spread use of systems which collect production and quality data from yarn machines.	2.33
135	Wide-spread use of sun-heat conversion technologies (collectors with vacuum systems) with conversion efficiencies increased by 25 % of their present average level.	2.33
396	Development of production technologies of local marine species products (sturgeon, eel, couches bream, mussel, etc.) with high economic value.	2.31
110	Wide-spread usage of SCADA systems for the detection and processing of data related to fire hazard, air pollution and security in tunnels.	2.31

Source: TÜBİTAK (2004b, p. 29)

Table B6: The Last 5 Delphi Statements with respect to Competency in Basic Science

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
237	Development of laser technology with adjustable power that is transferable in flexible media and can be used in cutting, welding, marking and in production of surface shapes smaller than 1/1000 nm.	1.25
238	Manufacturing of lithography machines with sub-100nm precision.	1.25
31	The commercial production of flat panel displays which are based on organic semiconductors and are larger than 37cm dimension beyond the present plasma and LCD technologies.	1.24
235	Large memory virtual reality eyeglasses with wireless data communication capability to be used in assembly and maintenance of complex mechanisms in industrial and service applications.	1.19
23	The number of organic integrated circuits used in one year to reach 10% of the total semiconductor integrated circuit number.	1.13

Source: TÜBİTAK (2004b, p. 30)

Table B7: The First 5 Delphi Statements With Respect To Innovation Capacity of Firms

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
117	Wide-spread use of Internet-based information, reservation, ticket purchasing and payment systems in public terminals for all modes of transportation and all types of tourism.	1.91
190	Wide-spread use of systems that collect production and quality data of textile machines.	1.88
195	Wide-spread use of systems that collect production and quality data from knitting machines.	1.88
112	The wide-spread use of RFID (Radiofrequency Identification systems) in all access control systems.	1.86
214	Wide-spread use of seamless junction in the ready made garment industry.	1.83

Source: TÜBİTAK (2004b, p. 34)

Table B8: The Last 5 Delphi Statements With Respect To Innovation Capacity of Firms

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
24	Development of an organic memory prototype which can transfer data to and from the human brain directly.	0.45
147	Development of nuclear reactor technologies for hydrogen production industrial heat production and purification of sea water applications in addition to electricity production.	0.44
338	Development of special purpose, new biomimetic catalyzer technology with high activity and selectivity.	0.38
22	Development of a general purpose DNA based computer prototype.	0.36
53	Development of bio-adaptive, artificial sense organs.	0.35

Source: TÜBİTAK (2004b, p. 35)

Table B9: The First 5 Delphi Statements With Respect To Existence of Competitive Firms

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
199	The wide-spread use of air jet technology in nonwoven fabric production.	2.25
212	The wide-spread use of Computer Integrated Manufacturing (CIM) systems in textile and garment industry.	2.15
195	Wide-spread use of systems that collect production and quality data from knitting machines.	2.13
193	Wide-spread use of technologies that will fully automatize pattern, type and model change in circular knitting machines.	2.13
194	The wide spread use of seamless junction technology in flat knitting,	2.09

Source: TÜBİTAK (2004b, p. 38)

Table B10: The Last 5 Delphi Statements With Respect To Existence of Competitive Firms

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
53	Development of bio-adaptive, artificial sense organs. (eye/ear/nose).	0.44
339	The development of bio-catalyzers for fast production of basic chemicals in lower temperatures with minimum waste.	0.41
23	The number of organic integrated circuits used in one year to reach 10% of the total semiconductor integrated circuit number.	0.40
52	Development of artificial learning and adaptive feet/knee/ankle joints.	0.38
22	Development of a general purpose DNA based computer prototype.	0.36

Source: TÜBİTAK (2004b, p. 39)

Table B11: The First 5 Delphi Statements That Are Expected To Be Realized In the Period 2003-2007

TÜBİTAK Delphi Statement No.	Delphi Statement
60	Wide-spread use of biochemical analysis (blood, urine, etc.) technologies in mobile health units.
187	Wide use of compact spinning technologies in ring yarn production.
183	Development of technologies that enable the loyal restoration to its original and preservation of our historical and cultural assets.
135	Wide-spread use of sun-heat conversion technologies (collectors with vacuum systems) with conversion efficiencies increased by 25 % of their present average level.
207	Wide-spread use of cogeneration plants with heat pump support in textile finishing plants.

Source: TÜBİTAK (2004b, p. 48)

Table B12: The First 5 Delphi Statements That Are Expected To Be Realized By 2023 and Onwards

TÜBİTAK Delphi Statement No.	Delphi Statement
63	Development of monitoring equipment that simultaneously enable different examinations.
335	Development of selective and stable castalyzers that will enable the conversion of products such as sugar and starch to valuable chemicals such as ethylene etc.
389	Realization of industry demanded special quality protein production by transgenic animal and core transfer technologies.
13	Providing a sense of contact to the objects and the live images in cinema and TV motion pictures to the audience who would like to take part in them.
58	Development of multi-functional, mobile microsystems which can get images from the cavities and veins of the body and can intervene when necessary.

Source: TÜBİTAK (2004b, p. 49)

Table B13: The First 5 Delphi Statements with Respect To R&D Project Support

TÜBİTAK Delphi Statement No.	**Delphi Statement**	(%)
56	Development of equipment for cell isolation, cultivation and modification for generation and application of stem cells, encapsulated cells or immunologically modified cells.	51.16
199	The wide-spread use of air jet technology in nonwoven fabric production.	50.00
200	Wide-spread use of water jet technology in the production of nonwoven fabrics.	50.00
198	Wide-spread use of ultrasonic technology in the production of nonwoven fabrics.	50.00
134	Development of portable solar cell technologies, with organic pigments and below 200 W power level.	47.62

Source: TÜBİTAK (2004b, p. 54)

Table B14: The First 5 Delphi Statements with Respect To R&D Infrastructure Support

TÜBİTAK Delphi Statement No.	**Delphi Statement**	(%)
205	Development of plasma and ion implantation technologies for the improvement of applications in textile products' surface qualities.	38.46
22	Development of a general purpose DNA based computer prototype.	38.46
235	Large memory virtual reality eyeglasses with wireless data communication capability to be used in assembly and maintenance of complex mechanisms in industrial and service applications.	34.48
254	Use of laser technologies that measures the dimension and location of 3-dimensional objects without contact and in an unpreconditioned medium with 1/10,000 mm precision, 100 % accuracy and high speed.	33.33
31	The commercial production of flat panel displays which are based on organic semiconductors and are larger than 37cm dimension beyond the present plasma and LCD technologies.	32.50

Source: TÜBİTAK (2004b, p. 55)

Table B15: The First 5 Delphi Statements With Respect To Start-Up Support

TÜBİTAK Delphi Statement No.	**Delphi Statement**	(%)
225	Wide-spread use of carbon-dioxide in dry-cleaning operations.	40.00
105	In railroad transportation, development of production technologies that will increase the rail length to 120m.	35.00
258	Development of systems that detect and interpret the bio-energy emitted by humans.	33.33
97	Development of unmanned construction machinery that can work underground.	33.33
190	Wide-spread use of systems that collect production and quality data of textile machines.	31.82

Source: TÜBİTAK (2004b, p. 57)

Table B16: The First 5 Delphi Statements with Respect to Guided Projects

TÜBİTAK Delphi Statement No.	**Delphi Statement**	(%)
95	Development of remote controlled and/or satellite controlled high capacity, high-efficiency construction machinery and equipment.	50.00
91	Development of remote/satellite controlled building management technologies.	47.06
340	Development of compact systems that produce biogas to reclaim solid biological wastes emanating from places such as sea platforms, houses and restaurants.	45.10
114	Development of horizontal and vertical road marking technologies that determine the average velocity and flow rate of traffic and transfer this data to a center.	44.83
329	Development of enamel permeated catalyzers for cleaning organic dirt from kitchen appliances in relatively low temperatures (50- 200 C) without water and detergent.	40.91

Source: TÜBİTAK (2004b, p. 58)

Table B17: The First 5 Delphi Statements with Respect to Human Resources Support

TÜBİTAK Delphi Statement No.	**Delphi Statement**	(%)
258	Development of systems which detect and process the bio-energy emitted by humans.	33.33
23	The number of organic integrated circuits used in one year to reach 10% of the total semiconductor integrated circuit number.	25.00
63	Development of monitoring equipment that simultaneously enable different examinations.	23.08
227	The production of OLED (organic LED) monitors to reach 50 % of annual monitor production.	23.08
96	Development of unmanned under-water construction machinery.	22.22

Source: TÜBİTAK (2004b, p. 60)

Table B18: The First 5 Delphi Statements with Respect to Public Procurement Support

TÜBİTAK Delphi Statement No.	**Delphi Statement**	(%)
34	Use of personal computers with internet connection instead of ballot boxes in election centers for parliamentary and municipal elections.	37.43
35	Secure on-line voting in parliamentary and municipal elections.	35.16
62	The use of smart cards that keep all medical records of the patient in digital format and are used in all medical units, by 25% of the population.	23.90
33	The necessary infrastructure for the remote reading and control of electricity, water and gas meters in Turkey (for example: automatic start of the service when the debt is paid) to reach the level of 50% of all meters.	22.96
3	Wide band communication services faster than 1Mbit /s over the subscriber interface infrastructures such as the present telephone and cable TV to reach minimum 20% of houses.	22.94

Source: TÜBİTAK (2004b, pp. 61-62)

Table B19: The First 5 Delphi Statements With Respect To Science, Technology and Innovation Capacity

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
24	Development of an organic memory prototype which can transfer data to and from the human brain directly.	2.77
22	Development of a general purpose DNA based computer prototype.	2.77
23	The number of organic integrated circuits used in one year to reach 10% of the total semiconductor integrated circuit number.	2.73
215	Development of clothing that can collect and transmit information about the user.	2.67
327	Development of catalyzer technologies which can make chemical and petrochemical synthesis using artificial photosynthesis methods.	2.64

Source: TÜBİTAK (2004b, p. 69)

Table B20: The First 5 Delphi Statements With Respect To National Added Value

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
355	75 % of vegetable (tomato, pepper, cucumber, eggplant, melon, pumpkin) production to be made with local hybrid varieties.	2.82
376	Increase the use of geothermal energy sources to 50% in hot-bed production.	2.80
356	75 % of sunflower production to be made from local hybrid varieties.	2.75
357	50 % of corn and potato production to be made from local hybrid varieties.	2.68
398	Development of suitable technologies for offshore cage fish farming.	2.67

Source: TÜBİTAK (2004b, pp. 70-71)

Table B21: The First 5 Delphi Statements With Respect To Quality of Life

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
51	Development of brain controlled artificial joint/hand/arm/feet.	2.86
72	Development of retarding release forms for generic healing recombinant proteins.	2.85
111	Wide use of road illumination systems that adapt to the density of traffic and weather conditions and provide energy conservation.	2.83
106	Development of software and hardware systems in high speed railway lines, that prevent human errors by processing all available information, including signalization and control of the trains' target speed.	2.82
92	Wide-spread use of programmable, auto-controlled and security hardware incorporating smart building technologies.	2.82

Source: TÜBİTAK (2004b, p. 72)

Table B22: The First 5 Delphi Statements With Respect To Competitive Strength

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
207	Wide-spread use of cogeneration plants with heat pump support in textile finishing plants.	2.80
355	75 % of vegetable (tomato, pepper, cucumber, eggplant, melon, pumpkin) production to be made with local hybrid varieties.	2.66
220	Development of advanced sensor technologies that enable precise monitoring of quality and immediate intervention to all production processes.	2.64
398	Development of suitable technologies for offshore cage fish farming.	2.57
402	Development of technologies for the optimization of preservation conditions to prolong the shelf-life of the packaged food.	2.56

Source: TÜBİTAK (2004b, p. 74)

Table B23: The First 5 Delphi Statements With Respect To Environment Friendliness and Energy Efficiency

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Index
207	Wide-spread use of cogeneration plants with heat pump support in textile finishing plants.	2.90
179	Development of low-cost technologies aiming to reduce the greenhouse gas that is produced by combustion processes.	2.87
177	Development of technologies that will enable environmental friendly operation of the mine reserves.	2.86
202	Wide-spread use of purification of textile conditioning waste water to reusable purity by reverse-osmosis, etc. methods.	2.86
176	Development of active purification technologies for the removal of poisonous residues from and for the improvement of soil.	2.85

Source: TÜBİTAK (2004b, p. 76)

Table B24: The 5 Delphi Statements with the Highest Importance Index (All Participants)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Importance Index
216	Development of clothing that can adapt to environmental conditions (heat, humidity, etc.)	80.68
107	Wide-spread use of electrically powered, rechargeable land transportation vehicles in urban areas.	80.05
299	Development of a (400-500 W), portable, small volume, long battery life (min. 7 days) power supply with adjustable output current and voltage for personal use (covering a wide spectrum from communication systems to electrical weapons)	78.97
24	Development of an organic memory prototype which can transfer data to and from the human brain directly.	77.69
207	Wide-spread use of cogeneration plants with heat pump support in textile finishing plants.	77.27

Source: TÜBİTAK (2004b, p. 83)

Table B25: The 5 Delphi Statements with the Highest Importance Index in Agriculture and Food (All Participants)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Importance Index
380	Development of integrated combat models that will reduce the use of agricultural insectisides in green-houses and fruit gardens.	80.10
378	Development of bio-pepticides that will reduce the negative effects to the environment and human health of chemical insectisides used in agriculture.	79.56
355	75 % of vegetable (tomato, pepper, cucumber, eggplant, melon, pumpkin) production to be made with local hybrid varieties.	77.99
350	Development of technologies that yield precise, correct, and repeatable results in ingredient and residue analysis.	76.96
169	Development of edible and/or biodegradable packaging material as an alternative to plastic and similar artificial packaging.	76.37

Source: TÜBİTAK (2004b, p. 84)

Table B26: The 5 Delphi Statements with the Highest Importance Index (Experts Group)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Importance Index
106	Development of software and hardware systems in high speed railway lines, that prevent human errors by processing all available information, including signalization and control of the trains' target speed.	84.92
207	Wide-spread use of cogeneration plants with heat pump support in textile finishing plants.	84.17
90	Wide-spread use of geographical information and remote sensing technologies for rapid and easy land survey and land registering operations, urbanization, monitoring of land movements, traffic control, landslide, flood, avalanche warning operations.	83.10
133	Development of multi-layered photo-voltaic cells which have a conversion efficiency of 50%.	81.48
141	Wide-spread use of technologies that enable hydrogen encapsulation and tranport in sodium boron hydride.	81.31

Source: TÜBİTAK (2004b, p. 84)

Table B27: The 5 Delphi Statements with the Highest Importance Index in Agriculture and Food (Experts Group)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Importance Index
355	75 % of vegetable (tomato, pepper, cucumber, eggplant, melon, pumpkin) production to be made with local hybrid varieties.	83.04
378	Development of bio-pepticides that will reduce the negative effects to the environment and human health of chemical insectisides used in agriculture.	82.52
380	Development of integrated combat models that will reduce the use of agricultural insectisides in green-houses and fruit gardens.	82.18
376	Increase the use of geothermal energy sources to 50% in hot-bed production.	81.90
379	Development of technologies that will reduce the loss of produce during and after harvest, in fresh fruit and vegetables.	81.13

Source: TÜBİTAK (2004b, p. 86)

Table B28: The 5 Delphi Statements with the Highest Feasibility Index (All Participants)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Feasibility Index
34	Use of personal computers with internet connection instead of ballot boxes in election centers for parliamentary and municipal elections.	63.38
35	Secure On-line voting in parliamentary and municipal elections.	62.90
218	Internet-based information transfer in and among management units in client-procurement chains using a standard language (software, coding, categorization, etc.).	61.40
195	Wide-spread use of systems that collect production and quality data from knitting machines.	61.38
60	Wide-spread use of biochemical analysis (blood, urine, etc.) technologies in mobile health units.	61.30

Source: TÜBİTAK (2004b, p. 88)

Table B29: The 5 Delphi Statements with the Highest Feasibility Index in Agriculture and Food (All Participants)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Feasibility Index
356	75 % of sunflower production to be made from local hybrid varieties.	59.78
357	50 % of corn and potato production to be made from local hybrid varieties.	59.06
403	Development of food formulations suitable for different age groups and nutrition habits.	58.46
355	75 % of vegetable (tomato, pepper, cucumber, eggplant, melon, pumpkin) production to be made with local hybrid varieties.	57.81
402	Development of technologies for the optimization of preservation conditions to prolong the shelf-life of the packaged foods.	57.11

Source: TÜBİTAK (2004b, p. 89)

Table B30: The 5 Delphi Statements with the Highest Feasibility Index (Experts Group)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Feasibility Index
60	Wide-spread use of biochemical analysis (blood, urine, etc.) technologies in mobile health units.	68.60
195	Wide-spread use of systems that collect production and quality data from knitting machines.	67.60
117	Wide-spread use of Internet-based information, reservation, ticket purchasing and payment systems in public terminals for all modes of transportation and all types of tourism.	66.81
193	Wide-spread use of technologies that will fully automotize pattern, type and model change in circular knitting machines,	65.31
114	Development of horizontal and vertical road marking technologies that determine the average velocity and flow rate of traffic and transfer this data to a center.	65.22

Source: TÜBİTAK (2004b, p. 89)

Table B31: The 5 Delphi Statements with the Highest Feasibility Index in Agriculture and Food (Experts Group)

TÜBİTAK Delphi Statement No.	**Delphi Statement**	Feasibility Index
368	Enable plant cultures to have C4 photosynthesis cycle instead of C3 photosynthesis cycle in order to increase the effectiveness of photosynthesis.	36.71
389	Realization of industry demanded special quality protein production by transgenic animal and core transfer technologies.	38.08
392	Definition of functional, genomic qualities of genes which control the important features of animals.	38.97
364	The use of DNA chip technology for fast determination of plant maladies and destructors, specification of plant varieties and functional genomic studies.	41.89
400	Wide-spread use of food safety methods for rapid determination of food with genetically modified structure.	42.10

Source: TÜBİTAK (2004b, p. 90)