THE SCIENCE AND TECHNOLOGY POLICY COUNCIL OF FINLAND

SCIENCE, TECHNOLOGY, INNOVATION

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Summary

Finland's strategy is to ensure sustainable and balanced societal and economic development. Thus far, Finland has been successful in combining economic development with the overall development of society and the environment and in increasing the citizens' well-being in an internationally recognised manner. In addition to other factors, this success is grounded in the high level of education of the population as well as increasingly wide-ranging development and application of knowledge and expertise. These national strengths must be safeguarded for the future. To this end, more international co-operation is needed.

The pivotal factors for realisation of the strategy are increasing employment, and, accordingly, decreasing unemployment, and ensuring high productivity and international competitiveness. In this context, research, the development of technology, exploitation of results, and strengthening of both social and technological innovation play a crucial role.

The national strategy must be implemented on a global scale. The aim is the versatile enhancement of Finland's position in the international division of labour. The implementation should focus on the essential and deliberately chosen key areas of competence with regard to the economy and society. It is crucial for innovativeness to be retained in realising these aims.

Realisation of benefits to the economy, employment, and well-being from research and innovation presupposes a diverse business sector with the ability to renew itself, and that there will be significant production activities in the future as well. With regard to this aim, the key development area is the creation and consolidation of high-quality innovation environments and infrastructures that bring together different stakeholders.

In short, the education, science, technology, and innovation policies of the coming years may be judged successful if they contribute to the development of the whole society and the innovation system in the intended manner. Success requires high-quality research and competence as well as honing of all activities within the remit of the Council. Success shall be evaluated on the basis of the overall impact of policy measures. The main principles in the development are prioritisation of operations, national and international profile-building and selective decision-making based on foresight. These are not enough on their own, but they are core elements in all development activities. Where the development of content, funding, and structures is concerned, the principles must be applied in accordance with this policy report.

The aim of development measures is to: 1) promote the overall functionality of the innovation system and the system's ability to renew itself, 2) enhance the knowledge base, 3) improve the quality and targeting of research, 4) promote the adaptation and commercialisation of research results, and 5) secure adequate economic prerequisites for the activities. The continuous development of human resources ensures top-quality competence for the future as well.

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Appendices

1 National strategy

1.1 Outline of the strategy

Finland's strategy is to ensure sustainable and balanced social and economic development. However, it is crucial for the economic development to be connected to the other developments in society and the environment as well as to increasing the well-being of the population. In addition to other factors, the positive development is maintained by the high level of education of the population as well as versatile development and application of knowledge and expertise. These mostly self-created national strengths must be retained in the future as well. In a globalised environment, more international co-operation is needed to this end.

The prerequisites for the realisation of the strategy are increasing employment, and, accordingly, decreasing unemployment, and ensuring high productivity and international competitiveness. Research, the development of technology, exploitation of results, and strengthening of social and technological innovation play a crucial role in this. The development of the service sector is particularly challenging. These factors play an essential role also in responding to the cultural and environmental challenges.

> *The employment rate has improved steadily but not quite as much as targeted. The seasonally adjusted employment rate was under 69 per cent in spring 2006. Such parallel questions as the sustainability of the public economy, prevention of socially negative development trends, and the quality and duration of employment all contribute to employment.*
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> *Throughout the country, unemployment has continuously decreased. However, the effect of internal migration is not specified in the figures. In spring 2006, the seasonally adjusted unemployment rate was 7.5 per cent. Much of this was due to structural unemployment of the oldest age groups.*

Positive development of the economy, employment, and well-being is closely tied to high-quality education, production and application of new knowledge and expertise, innovations, and production and trade based on high-tech industry. These same factors have also a crucial impact on productivity. Growth of productivity is necessary in both the public and private sector, and particularly in the area of services. In the business sector, the need to increase productivity is a challenge to all lines of business and to enterprises of all sizes – this applies also to the areas where productivity is already high by international standards (i.e., the paper industry and forestry, the manufacture of communication equipment, and metal processing). In addition, reaching the objectives of the national strategy requires increased investment in both fixed and immaterial investments.

For the last 10 years, the growth of the GDP in Finland has been among the best in the OECD and significantly faster than the EU average. However, when measured in terms of GDP per capita in PPS, we rank approximately 15th in international comparison. The productivity of labour (per hours worked) is still below the average for the EU15.

Productivity in industry is at the top level internationally, whereas in services it is only at the EU average. In addition, differences in productivity between branches are great, even in industry. Reports on the efficiency and productivity in the public sector contain very mixed findings. This demonstrates how difficult it is to come up with reliable measurements by using the current methodologies. The greatest growth potential for productivity seems to be in the development of services and in the efficient and wide-ranging application and introduction of generic technologies creating new opportunities (ICT, nano, bio) in various fields. For example, the exploitation rate of ICT in SMEs and services is low, and the productivity benefits are thus unrealised.

Increase in the investment rate and expansion of production capacity has so far been fairly modest in Finland. However, fixed investments in industry have shown a slight increase since 2004, which has brought the investment rate close to the Western European average. Increasing fixed investments, especially expansion investments, together with R&D expenditure are important with regard to maintaining and developing both production and innovation.

Success in international competition also requires increasing the value added to products and services. The focus must be moved more strongly toward knowledge- and technology-intensive high-value-added production and toward the tag end of the value chains that produce surplus value.

Competitiveness is measured with international comparisons, the most well known of which are the *Innovation Scoreboard* of the European Commission (most recently, 12 January 2006), *WEF* (28 September 2005), and *IMD* (11 May 2006). Topics reviewed include the level and output of research and innovation, the rise in GDP, the balance of current payments, the state of the environment, and various social indicators. In these comparisons, Finland's strength has been shown to be its success across many different sectors.

The effect of globalisation can be perceived as changes in the industrial structure and labour markets. The number of jobs in industry has decreased. New jobs have been created in the service sector and high-competence expert and research tasks. Changes in occupational structure and increases in competence demands are typical features of the labour market development. This requires the comprehensive development of education and work life; it is a question of raising the quality of education, improving the correspondence between education and work life, and ensuring an adequate high-competence educational reserve. The efficiency of the educational system and accurate anticipation of education and labour needs are key issues for the implementation of the national strategy and the efficient use of limited resources.

National measures have a pivotal effect also in globalised circumstances. Globalisation entails diverse, even contradictory development, which is difficult to control. The clearest

manifestations of globalisation are large multinational enterprises, which have a leading role in the global market. However, they are still connected to their location, their operations are based on local prerequisites, and they have special national and local characteristics. Therefore, domestic policy decisions, strategic choices, and development activities creating a competitive edge are important. A strong, forward-looking approach must be retained in responding to pressures for change.

> *Interdependency of countries, areas, and actors grows with the progress of globalisation such that competition and co-operation are concurrent phenomena. Therefore, it is important to be able to enhance co-operation and interaction with both partners and competitors simultaneously. Success in this presupposes continuous renewal of the innovation system and education, improvement of responsiveness, and an ability to adapt to changes in a proactive manner. One must know how to act in various environments and in a new way; top competence is not enough on its own. One needs social and cultural abilities and skills. The education system must be thoroughly internationalised, and at the same time we must ensure that those entering work life have adequate capabilities for interacting at an international level. On the system level, research and innovation and their steering, funding, and support organisations must be equally internationalised alongside education.*

All of the basic factors of the national strategy can be affected by efficient and well-directed education, science, technology, and innovation policies. The question is: what are the right contents of these policies to maximise their positive effects and distribute them for the benefit of the whole population?

On a general level, the answer is that the above-mentioned policies must be able to respond to global mega-trends and simultaneously support the continuing development of domestic activities on the current basis. Recognised trends include:

- increasing internationalisation on all levels
- continuing change in economic and social structures
- competitive factors directed at the innovation dynamics
- changes in R&D: increased professionalism, co-operation and networking, growth of the size of units and infrastructures, interdisciplinary and cross-technological activities.

In addition to these, a trend particularly evident in Finnish society is the ageing of the population. In the next two decades, the number of young people entering the labour market will be less than the number of people leaving the workforce. This will narrow the public economy's room to manoeuvre and will increase pressures on the sustainability of the economy. Ensuring an adequate level of knowledge and expertise, as well as the balance of the economy, involves major challenges. Also, in this sense, the increasing number of people continuing their active work careers longer than before is a positive signal.

Development demands directed at policies are twofold. Firstly, the policies must promote the development of the entire society, and, secondly, they must contribute to improving the production of innovations that support development and the functioning of the innovation system. The policies will be, correspondingly, based on existing strengths and the need to

create new ones: knowledge, competence, education, research, and innovation must be developed systematically and continuously.

> *The contents of education, science, technology, and innovation policies are determined by their impacts on the national strategy. From the bottom-up perspective, it is well founded to maintain a comprehensive, high-quality education system. However, the volume of education and its extent, by field and education level, must correspond better to the future labour demands. On the general level, focusing on this development work does not belong to the tasks of the Science and Technology Policy Council, but focusing on professional researchers and the research system very clearly does.*
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> *From the top-down perspective, the question concerns what policy recommendations are needed at national and possibly at regional level. It is essential to ensure that development measures at regional and local level and the national policy are interactive and support each other. Well-developed foresight activities support the decision-making processes strongly in this respect.*
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> *Questions of demography do not simply deal with a quantitative examination of labour supply and people leaving the workforce. Changes in the labour market and in qualifications, and a conscious effort to widen the recruitment base, have an enormous effect on the overall situation. The special task of the Science and Technology Policy Council is to review the renewal and growth potential of the researcher community in the production and application of new knowledge. This review includes also the growth in short-term external research funding and the increase in project-based activities, as well as the subsequent increase in successive fixed-term appointments. In the long run, these have an adverse effect on the continuity of research, the accumulation of research-based knowledge, and the consolidation of the competence base.*

The profiling of research and funding organisations is promoted by both their internal and multilateral co-ordinated measures. The profiling is supported by incentives and steering mechanisms, such as the development of funding principles and instruments and the performance-based management.

> *A key challenge is to intensify top-quality research and innovations in the fields that are the most crucial for the national economy; development of society; and the citizens' economic, social, and cultural well-being. Among other things, this requires prioritisation, international and national profiling of research organisations, and strengthening of selective decision-making based on foresight.*

Strengthening of selective decision-making applies to all levels. It also concerns political decision-making that deals with the future development of society and the economy and determines the manner of addressing core development questions concerning knowledge and competence and their exploitation necessary for the realisation of goals, large-scale international science and technology commitments included. Successful choices and prioritisation presuppose an adequate knowledge base and determined decision-making. Therefore, it is necessary to strengthen the prerequisites for, and preparatory mechanisms

of, decision-making. This may occur through improving the connections between decision-making and expert advice, strengthening competence in foresight and evaluation, and implementing development projects connected with these functions.

Success in producing innovations is the key factor for the favourable development of both enterprises and societies. Finland has implemented a strategy aiming at this goal since the early 1990s. Future success calls for sufficient investments, high-quality research, and top-quality competence in technology and business.

Alongside technological innovations, there is a need for determined investment in the production and commercialisation of social innovations. At the societal level, social innovations are particularly necessary for ensuring that economic and technological development do not diverge from the rest of societal and social development, and to create a favourable and steady breeding ground for economic and technological development.

As strategic steering and development organisations, ministries have a significant role to play in this. They must focus their activities on, among other things, promoting the production, commercialisation, and exploitation of social innovations. Strengthening the ministries' competence and increasing the horizontal co-operation are likewise needed.

> *The realisation of the national strategy presupposes the following subject matter in the field of science, technology, and innovation policy (discussed later): dealing with structural issues, wide-ranging development of innovation, preventing marginalisation, and increasing the efficiency and performance of the innovation system (improving its productivity).*

Instead of directly steering and regulating the markets, the state today focuses on improving the framework conditions and capabilities of the economy and society. It is the task of public authorities to put in place the basic prerequisites for innovation – that is to say, to ensure that the funding, legislative framework, infrastructure, education and research systems, etc. are of high quality and the ability to respond to changes will be maintained. A wider perspective would also include other factors, such as ensuring the smooth functioning of energy supply (availability and cost of energy, environmental sustainability). The aim is to ensure that conditions are favourable for creating competitive and creative innovation environments.

> *The exploitation of changes requires speed and flexibility; an ability to create the necessary critical masses; and, of course, quality and relevance in one's own activities. In globalised circumstances, it is crucial to create one's own development paths and competitive edges; it is not simply a question of adapting to changes in the environment.*
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> *The realisation of the national strategy presupposes strengthening of national competencies and recognition both of promising research areas and innovation opportunities and of how to maintain existing competitive edges and create new ones. Furthermore, success presupposes the ability to 1) acquire foreign competence and capital, 2) participate in multilateral co-operation, and 3) exploit new opportunities on a global scale.*

For a long time, investments in research and innovation have been at an internationally high level in Finland. A long-term, predictable increase in public investment in education and research is important. At the same time, more emphasis must be placed on development activities and funding, which make the exploitation and commercialisation of research results more effective. Strengthening of public–private partnerships and development of new operational models are crucial in relation to this aim.

Naturally, alongside activities directly speeding up the development, measures preventing and removing threats and obstacles to balanced development are needed. What is at stake here has been discussed in great detail in the SWOT analysis drawn up by the Science and Technology Policy Council, and which is a part of the strategy document 'The Internationalisation of Finnish Science and Technology' approved by the Council in November 2004 (see the appended table).

1.2 Focus areas

In the area of content development, it is crucial to promote measures implementing the national strategy. The strong sectors of the Finnish economy – the forest industry, the metal industry, and ICT – must retain their position. New areas of focus must be created alongside them from a group of promising branches, including at least biotechnology, new materials, software, knowledge-intensive services, the entire well-being cluster, and the most recent area: nanotechnology. New initiatives connected to culture and leisure time are likewise important. Generally speaking, it is a question of a need to understand the entire service sector, such as industry, as a core part of the economy, determining the well-being of citizens.

The service sector is a key development target at the same time as its significance to the economy and employment grows. Export of services has increased rapidly and was worth over €9.7 billion in 2005, which exceeded the amount of corresponding imports by almost €4 billion. This accounted for over 40 per cent of the entire foreign trade surplus. Particular challenges for services are how to improve productivity and quality, increase research and innovation, and develop partnerships between public and private actors – as well as internationalisation and linkage to the export industry. One of the most rapidly growing areas of services is business services. Business services support the R&D and innovation and promote the renewal and internationalisation of the other sectors. These services have an increasing role in transferring technology and competence within and between sectors and clusters.

On a more general level, the question is one of creating and strengthening internationally competitive competence clusters and centres of excellence in science and technology. In June 2006, the Science and Technology Policy Council has adopted a strategy aiming at achieving this. The vision is to create international strategic centres of excellence in science, technology, and innovation in the fields of competence most critical to the future of business and society. The aim is to allocate already existing and new R&D resources to the centres in a new way and on a clearly larger scale than hitherto.

The question of strategic centres of excellence is connected to the development and more intensive exploitation of large-scale core infrastructures. In autumn 2004, the Science and Technology Policy Council gave detailed procedural instructions for the formulation of national views on large-scale international scientific infrastructures. Similar preparation is under way for infrastructures of national scale. The task is challenging for several reasons. Investment in infrastructures of this magnitude (for example, the Finnish IT Center for Science (CSC) or the five Finnish biocentres) has been more of an exception than a rule, which is why applicable funding models have not been developed. In the current situation, this is discernible as a severe shortcoming when one evaluates European infrastructure initiatives (ESFRI) and the national investments needed for these projects.

As a result of the above, the public research system is facing serious challenges. The aim of developing the universities is to build up a high-quality university institution with top international expertise in those fields of strength that are relevant to the Finnish economy, education, and research, and with the ability to renew itself and react, thus providing new research initiatives. The Prime Minister's Office has appointed a working group to develop sectoral research, the task of which is to draw up an overall plan to direct sectoral research and its resources in accordance with the changed needs of society. The Technical Research Centre of Finland (VTT) has the special task of continuously developing its competitiveness and basic competence in selected areas important for Finland.

> *The development of contents is supported by both funding and structural means. The Science and Technology Policy Council will comment on several major proposals dealing with the creation of large-scale units in selected fields, domestic investments required by future European infrastructures in fields important to Finland, or the creation and funding of large domestic infrastructures for the general development of research. Currently, there are no decision-making procedures or funding mechanisms available for any of these. Reaching viable decisions requires good co-operation between expert and funding organisations and political decision-makers as well as well-functioning partnerships between the public and private sector.*

Understanding the importance of high-quality innovation environments has also led to the activation of regions in exploiting new knowledge and expertise. Competitive edges for enterprises are created and maintained through decisions made by local actors at a local level. The role of the regions in developing regional innovation is substantial. At the same time, it is important for the co-operation and division of labour between regional and national actors to be improved and for the new Centre of Expertise Programme, to be launched on 1 January 2007, to be clearly focused on top competence and its exploitation. On the basis of the project proposal call, which ended in May 2006, it can be stated that the interest in developing regionally driven clusters reaching international standards is considerable throughout the country.

1.3 Funding principles

In terms of international comparisons, Finnish research funding has been developing very favourably. Both private and public investments in R&D are among the highest in the EU and the OECD. National investment has been growing continuously both in terms of volume and in relation to GDP ever since R&D statistics were first employed in Finland, in

the early 1970s. In 2004, the research volume was €5,250 million, which represented 3.5 per cent of the GDP. Estimates for 2005 suggest that the growth is continuing.

However, a closer look at the funding reveals that there are structural weaknesses in the funding in both the public and private sector.

The *Finnish business sector* appears to be very research-intensive in international comparison. Enterprises' proportion of total R&D expenditure is 70 per cent, close to €3,700 million, and they provide 68 per cent of the funding. Within the sector, the share of industry decreased from 82 per cent in 1998 to less than 80 per cent in 2004. This is due mainly to two factors: the strong growth of the volume and of the share of knowledge-intensive services and the weak development of R&D in fields other than the electronics industry. While the Nokia-led research volume of the electronics industry nominally grew by 83 per cent between 1998 and 2004, the corresponding figure for the rest of the industry was a mere 19 per cent. The electronics industry's share of the total research volume grew during the period by 10 percentage points, to 71 per cent and nearly €2,100 million in 2004. The respective shares of the two traditional pillars of Finnish industry, wood processing and the metal industry, decreased and, in 2004, together represented only 16 per cent of the total research volume of industry.

The R&D volumes of small enterprises with less than 10 employees have grown, even nominally, quite slowly: by less than seven per cent during the above-mentioned time. The slow growth does not say as much about the scarcity of research funding as it does about the relatively small number of research-based start-ups. The largest single problem these enterprises have is that private venture capital investors are not keen enough on start-ups; the public sector accounts for 90 per cent of that particular area of innovation funding.

Since the late 1990s, *public research funding* has been characterised by a strong increase in competitive funding – its share of public research funding increased in 10 years from 25 per cent to 42 per cent in 2005. The funding volume of financing organisations during the period mentioned has grown significantly, as can be seen from the following Statistics Finland data.

Government research funding in 1991–2005 (€ million, current prices):

	1991	**1995**		**1996**	**2000**	**2005**
Academy of Finland	75.6	77.1		84.4	153.8	223.5
Tekes	156.5	243.9		246.2	390.8	448.4
Subtotal	**232.1**	**321.0**		**330.6**	**544.6**	**671.9**
Universities	226.3	220.4		258.6	346.4	416.7
Research institutes	209.9	194.6		196.1	215.8	259.4
Other research funding	131.5	158.0		153.4	189.1	248.7
Total	**799.7**	**894.0**		**938.8**	**1295.9**	**1596.7**

There is a break in time series in 1991, 1995, and 1996. The year 2006 is not yet comparable because the data do not yet include all of the funding from the supplementary budgets. Therefore, the following review of change in real terms has been done in three parts: 1991–1995, 1996–2000, and 2000–2005.

Development of government research funding (%, in real terms):

	1991–1995	1996–2000	2000-2005
Academy of Finland	- 4.9	+ 64.1	+ 25.7
Tekes	+ 45.1	+ 42.9	- 0.8
Universities	- 9.2	+ 20.6	+ 4.0
Research institutions	- 13.6	- 0.9	+ 4.0
Research: EVO *	-	..	- 40.7
Other research funding	+ 12.0	- 23.9	+ 38.9
Total	**+ 4.2**	**+ 24.3**	**+ 6.7**

***** Government compensation for research carried out in university hospitals (based on the Act on Specialised Medical Care, starting from 1997).

The development of the basic funding for universities in Finland is based on the Higher Education Development Act, first introduced in 1966. According to the current version of this act, universities have been guaranteed an annual funding increase in real terms for 2005–2007. It is a well-known fact that universities have to spend the majority of this increase on rent and other real-estate expenditure; i.e., the actual operational funding has hardly increased at all. The modest increase in basic funding for government research institutes points to the ministries' aim to make research institutes increase the volume and the share of their external funding. Indeed, the share of external research funding has increased in the past 10 years by, on average, eight percentage points, to 44 per cent in 2006. However, only two of the 20 institutes (VTT and the Finnish Environment Institute, SYKE) are above the average.

In both universities and research institutes it is still typical that the share of overhead costs of external project funding is far too low. This is possible because the cost accounting of the organisations in question has not been appropriately developed. The Ministry of Finance has appointed a committee one of the tasks of which is to develop uniform principles to be used in the cost accounting for operations receiving joint funding. The committee will complete its work by the end of June 2007.

Another area for development of external funding is taxation. The tax exemption limit for donations for research funding by enterprises to universities is only €25,000. Raising the limit would promote the interaction between universities and enterprises in a mutually beneficial manner.

The increasing importance of financing organisations has simultaneously emphasised their role and responsibility for the functioning of the entire public research system. The evaluation of the Finnish innovation support system in 2003 also remarked on this. The replacement of the linear innovation model with a model based on interaction within and between the different stages of the innovation process has expanded the tasks of the organisations and increased their mutual overlapping. The development trends are reinforcing each other in such a way that if competitive research funding is still primary in

the overall funding, the financing organisations have to expand their functions to areas like instrumentation and infrastructure funding.

The rapid increase in research volume poses challenges also for researcher education, in order to ensure that the level of education of the research personnel stays high while R&D expands. Thus far, we have succeeded well in this, as is explained in Section 1.7, 'Development of human resources'. In this context, the development of graduate schools, the weight given to doctoral degrees in the basic funding of the universities, and the long-established connection of researcher education to research funding from the Academy of Finland have been central features. However, simultaneously, investment in post-doctoral research careers has been left without adequate attention. These have not been developed in the way required by the increased research. This is a major challenge for both the entire research system and financing organisations.

According to the Government Strategy Document 2006, "public research and development funding will be increased with the aim of raising the GDP share of private and public research funding to 4 per cent by the end of the decade". However, increasing research funding is not an end in itself. Sustained and predictable development of research funding is crucial to the fulfilment of goals set for science, technology, and innovation policy. Public funding increases the benefits gained from the investments. It also encourages enterprises to increase their research investments and enhance their innovation. Funding must be directed at attaining the contentual goals and decreasing the fragmentation and other deficiencies of the R&D. In particular, attention must be paid to ensuring that the funding structure (direct budget funding and competitive funding) of research organisations is in balance and sustainable with regard to their basic tasks and long-term development of the knowledge base. These principles apply both to the use of current funding and to new resources, the need for which is universally recognised in Finland.

The Science and Technology Policy Council's report on Strategic Centres of Excellence and infrastructure policy will concretely steer the allocation of funding. In the Government Strategy Document 2006, it is furthermore stated that preparations for these measures will take place when the next budget framework is drawn up (early 2007).

Different development stages of enterprises and various needs attached to them have not been comprehensively taken into consideration with regard to funding. Moreover, the Science and Technology Policy Council has not paid enough attention to the field of innovation funding and functioning of financing instruments as a whole. Efforts to remove the discontinuity that is apparent at the interface of the research and innovation funding have been initiated through public measures with risk financing falling in between funding of R&D and operations of private venture capital investors. At this stage of the innovation process, there are also other targets in need of investment, such as business competence and, more generally, taking up entrepreneurship.

The development of European research and innovation areas and the recently suggested innovation market pact are important for Finland from the perspective of both research and business.

> *The common phrase 'to be developed from the current basis' does not mean that the development of the content of activities can be realised with new resources only. The common requirement for more focused activities is directed*

to the existing field of activities. Decreasing the fragmentation of funding in order to create larger entities is a key principle. The new resources will be allocated on the basis of the content needs. Tailored financing mechanisms will be used when needed. Improvement of conditions for maintaining strengths and exploiting new opportunities is another key principle.

1.4 Development of structures

Flexibility of the innovation system – its good capability for self-renewal – is a precondition for the realisation of the national strategy. The Council paid attention to this issue in its previous report, in which it set itself the task of evaluating the structural development of the entire public research system.

A particular reason for launching the project was that the science, technology, and innovation policies were implemented by almost the same basic organisation for 20 years, ever since the founding of Tekes (the Finnish Funding Agency for Technology and Innovation) in 1983. Of course, founding polytechnics in the early 1990s and giving them a permanent status in 2000, and developing the public innovation support system after the launch of the Employment and Economic Development Centres (T&E Centres) in 1999 have been most significant measures. However, the importance of the older national actors – the Academy of Finland, Tekes, the universities, and the research institutes – in the entire system has simultaneously continued to increase, and their previously separate tasks have begun to overlap in ways corresponding to the new forms and needs of research and innovation. Therefore, there was every reason to evaluate how this traditional organisation is coping with challenges and the need for flexibility and renewal.

In 2005, the evaluation project of the Council launched in 2003 led to a Government Resolution document on the structural development of the public research system. This Resolution is appended to this report. The Council's work was supported by a number of separate studies, which shed light on the structural issues of universities, ministries, and public research institutes, as well as intermediary organisations operating at the interface between the public research system and the rest of society.

No need for radical changes in the structure of the public research system was recognised. However, the Government Resolution presupposes the implementation of rather diverse development measures. The ministries will report on the implementation of the resolution to the Science and Technology Policy Council and to the Government for the first time in June 2006. The aim is to implement such structural development, with the help of which the education, science, technology, and innovation policies aiming at the implementation of the national strategy can be supported. Due to this general objective, the resolution includes also development principles pertaining to content and operations. These are discussed in the appropriate sections of this report. The development principles will steer the policy measures in the near future as much as the parts of the resolution that clearly pertain to the structures.

At system level, the interaction of national policy advice and political decision-making will be strengthened. To this end, a new Government decree on the Science and Technology Policy Council of Finland came into force at the beginning of 2006: the term of the Council has been changed to correspond to the electoral period; the secretariat of the Council has

been enforced; and key sectoral research fields will be taken into account in appointment of ministerial members to the Council. Within the Government, the Cabinet Committee on Economic Policy will handle the central issues in relation to science, technology, and innovation policy. Once every electoral period, the Government provides the Parliament with an opportunity for a comprehensive discussion bringing together these policy sectors.

The key expert organisations in the public research system in Finland are the Academy of Finland, Tekes, and Sitra (the Finnish National Fund for Research and Development). Intensification of their interaction is important, particularly with a view to enhancing the impact of research and innovation funding and creating functional entities larger than the current ones.

Universities and polytechnics form the Finnish higher education network, which is exceptionally dense and regionally comprehensive in international comparison. The higher education network comprises 20 universities and 29 polytechnics. Education leading to a higher education degree is given in over 100 localities in Finland. In addition, the universities have numerous research and field stations as well as adult education units enhancing the regional supply of higher education in various localities.

This development has led to the fragmentation of higher education – the creation of many small, narrowly focused units. The strong confidence of the regions in the positive effects of higher education has contributed to this. This is demonstrated by the over 200 endowed professorships and the education projects implemented through the EU structural fund programmes. General requirements concerning the quality and efficiency of higher education have not in all respects been realised in these projects. On the other hand, the higher education network has been intentionally built to be regionally comprehensive, so that all of the country's talent resources can be exploited and to promote equal opportunities in education. However, a decrease in the size of younger age groups increases the need to critically examine the education and unit structure.

In spring 2004, the Ministry of Education presented the indicative objectives for dimensioning the supply of education by regions. The most explicit pressure for reducing higher education supply is mainly felt in Eastern and Northern Finland. The supply of university education in the Helsinki metropolitan area could be reduced somewhat. The universities in the area should enhance their co-operation and combine their strengths. Universities both in the Helsinki area and elsewhere should sharpen their profiles in research.

In recent years, there has been an ongoing effort to enhance the regional impact of universities through co-operation and networking. The fragmented university activities of six urban areas (Lahti, Kajaani, Kokkola, Mikkeli, Pori, Seinäjoki) have been assembled into the so-called university centres. Further development of the co-operation with polytechnics both intensifies the regional impact and makes the use of resources more effective.

The degree system in higher education has been developed strongly in recent years. This work aims to respond to not only international developments but also the requirements of work life and the society. The aim is that approximately half of each age group would complete a higher education degree. This is a challenging target, because all Finnish higher education degrees take at least three years of full-time studies.

The principle of the Finnish three-tier higher education system is straightforward. The problems are long completion times and the relatively low completion rate for higher education studies. Moving from one higher education sector to another is not entirely unproblematic, due to deficiencies in the credit transfer system.

At the European level, the rationale behind the development of degrees is provided by the European Qualifications Framework. This means that qualifications are set for the degrees instead of the study time or format of the course being fixed. This thinking is strongly based on the idea of lifelong learning and individual educational paths.

Estimating from this perspective, we conclude that the Finnish higher education system does not offer enough flexibility, nor is it built sufficiently on the evaluation of real qualifications of the students when moving from one sector or field to another.

Structural measures are also required for the development of research and for keeping it internationally competitive. In particular, top research is increasingly built around strong competence clusters and around creative research environments and high-quality infrastructures reaching the so-called critical mass. The lack of these has been recognised, for example, in the education and research in the field of technology. Focusing of activities and the necessary consolidation of economic resources in the field are closely interconnected issues.

Measures have been launched to set up the higher education network. In the 2000s, in accordance with the Government Resolution, mergers of units and reorganisation of operations have been performed in the polytechnic sector. Educational services have been brought together into larger and more functional units in, for example, the regions of Rovaniemi, Oulu, and Turku and in Swedish-language education in the provinces of Uusimaa and Southwest Finland. In 2003 to 2005, the number of polytechnic units has been reduced by ten.

In the university sector, for example, the Department of Construction Technology at the University of Oulu and health-care education at the University of Helsinki were discontinued in the 2000s. There are ongoing surveys concerning enhancement of the co-operation and its structures in the three art academies and concerning co-operation networks within the field of economics in Eastern and Northern Finland. In addition, universities have made significant reforms in their internal structures and increased their network-based co-operation.

Many university towns have engaged in creating campuses where the universities, R&D institutes, polytechnics, and enterprises are located within easy reach of each other. Proximity increases cross-sector interaction, researcher mobility, and the development of innovative research environments. The campus co-operation will increase and intensify cross-sector projects, make the joint use of infrastructures and other forms of co-operation more efficient, and increase investments in Finnish production and competence.

The university system will continue to be developed as an entity comprising universities and polytechnics, the ‘University and Polytechnic of Finland’. Key development principles are specialisation and networking. The structure of the higher education network will be renewed through merging units into larger entities by reducing the number of units. The regional university network will be retained even though there will be fewer units and the

remaining units will be larger. The co-operation between universities and polytechnics in the same locality must be improved. Merging higher education institutions on the basis of their own analyses is a realistic development option in many cases. However, in implementing structural changes, the Ministry of Education's guidelines and active approach to performance-based steering of universities are needed.

> *More efficient use of resources requires reducing the number of overlapping operations, deepening the co-operation between higher education sectors, and creating functional entities larger than the current ones. The declining number of young people requires the evaluation of dimensioning and reallocation of higher education supply. In order to ensure balance among disciplines, regions, and language groups and to avoid duplication, the supply of higher education must be steered in both the university and polytechnic sector in accordance with consistent principles. The structures and organisation of further education and the Open University must be made more effective through co-operation between the Ministry of Education, other maintainers of higher education institutions, and the institutions themselves.*
>
> *University and polytechnic support services, library and information services, international activities, adult education, innovation services, and co-operation with enterprises could be organised more economically than at present by merging operations and developing new co-operation models. Rationalisation of activities will provide higher education institutions with an opportunity to improve the quality and impact of their basic tasks.*

European dialogue has also noted that the lack of funding and the presence of old-fashioned steering and administration systems at universities are key challenges in improving Europe’s competitiveness. According to the European Commission, the higher education expenditure should be at least two per cent of the GDP. The goal should be a better utilisation of resources, so that resources will not be wasted on overlapping and fragmented activities or oversized institutional structures.

There is an intention to increase the financial autonomy of the universities. Increased financial autonomy and fund-based finance are to be introduced in all universities, which, alongside performance-based steering and accountability, give the universities more room to manoeuvre and create the prerequisites for strategic development by the universities themselves.

> *Increasing financial autonomy gives the universities new opportunities to renew structures and create partnerships with other parties. However, increasing autonomy presumes that universities will improve their overall governance of funding and finances. This requires determined reform of the university management and administrative structures.*

Sectoral research accounts for about half of the research of the university sector. All ministries have the responsibility to develop and exploit research within their respective sector. Finland has 20 government R&D institutes, in eight policy sectors, in addition to which an international relations research institute attached to the Parliament will be established at the beginning of 2007. The institute will be based on the current Finnish Institute of International Affairs, and this name will be passed on to the new institute.

The field of sectoral research has been considered to be rather fragmented, and the government R&D institutes are not perceived as forming a functional entity. The above-mentioned Government Resolution document required the ministries to draw up comprehensive development and exploitation programmes of sectoral research for their respective sectors. After the completion of the programmes, a working group, which was equally required by the Resolution, was appointed to draw up an overall plan for targeting sectoral research and allocating its resources in accordance with the changing needs of society.

The key starting points of sectoral research are the research needs of society. In all sectors of society, it must be ensured that the necessary research knowledge is promptly available and that it is also exploited in administration and decision-making, as well as in developing public services. Traditionally, sectoral research has been examined from the perspective of a single research institute or administrative sector. This is one reason the resources of sectoral research are not duly allocated.

Sector policies are increasingly based on domestic and foreign research, social and other innovations, and their efficient exploitation. Therefore, it is topical to undertake a comprehensive review of sectoral research and co-operation and division of labour among policy sectors as well as among research institutes. Gaps in research and future research needs must be examined alongside the functional development of research. Also the dynamics of sectoral research must be improved. The work of the committee appointed by the Prime Minister's Office (PMO) will be completed by the end of 2006.

VTT is a special case among the government R&D institutes. As VTT is the largest research institute in the Nordic countries, its significance as an expert organisation in applied technological research and development of technology is exceptionally important. The development of the competitiveness and basic competencies of VTT is linked to the selection of areas of focus and the increase in their basic funding. Now VTT is being transformed from a technology developer into an innovation developer. In accordance with this, resource increases are allocated to strategic basic technological research; to market prediction and analysis, new technologies, and competitiveness of enterprises; and to the conceptual development of technology, services, and business.

There are several hundred *intermediaries* operating at the interface between the public and private sector. Alongside science parks, technology centres, and business incubators, there are various public and private innovation services and municipal arrangements. In accordance with the resolution, the Ministry of Trade and Industry has a special task: to develop processes that intensify and connect operations at both regional and local level. Technology centres play a significant role in this. These issues are discussed in more detail later, in Section 1.8.

The structural evaluation and the measures taken up by the Government on the basis of the evaluation have clearly shown that education, science, technology, and innovation policy targets will not be reached without structural development. As with funding, the question is of striving for new goals and strengthening already existing competitive edges, as well as removing weaknesses and threats revealed by the SWOT analysis (see the appended table). Prioritisation, unit sizes reaching so-called critical mass, and pooling of resources via co-operation of public and private parties cannot be realised in practice if the structures do not support the required profile-building and more selective decision-making.

The ministries will report on the implementation of the resolution to the Government through the Science and Technology Policy Council by 30 June 2006. On the basis of the reports, the Council will present an evaluation of the implementation process. As for the sectoral research, the concrete measures will be formulated by the PMO working group by the end of 2006.

1.5 Internationalisation at the heart of development activities

Due to the intensification of links between international, national, and local development, the effect of trends in the world economy on all sectors of society has grown and become more direct. Market and co-operation relations have deepened, and competition for production, labour, and critical success factors such as a skilled labour force and capital has stepped up. In these circumstances, the challenges and demands of internationalisation for the Finnish innovation system are emphasised.

Internationalisation of Finnish research and innovation is necessary for three interconnected reasons: 1) our own intellectual and financial resources are limited and a significant amount of the knowledge and competence we need is produced abroad; 2) international co-operation is a means to improve the quality of research, remove overlapping activities, and bring together domestic parties and funding for joint projects; and 3) being part of the globalisation of science and technology is in the best interests of Finland, as is participating in the intensifying and increasing R&D at the EU level in support of the Lisbon Strategy. Our own high-level competence is a precondition, particularly for seeking interaction with leading global centres and actors. Therefore, it is essential to systematically develop the national knowledge base and to identify new strengths early on. Success in this leads to self-affirming positive development.

Development of activities and quality assurance based on only a national perspective are not enough to succeed in international competition. Domestic researchers, financiers, and enterprises must position themselves in the international operating environment. They also have to be able to develop their strategic competence and co-operative abilities in a target-oriented manner. Improving abilities requires continuous development of the education and innovation systems in a way that corresponds to changes in the structures of business and society and enhances innovation dynamics.

International co-operation is not a separate function; it is an intrinsic part of Finnish research and innovation and their development. The same quality and relevance requirements apply to both domestic activities and international co-operation.

The challenges and development issues presented by internationalisation are threefold. The question is one of co-operation engaged in by Finnish researchers, institutions and enterprises abroad, the operations of corresponding foreign parties in Finland, and co-operation taking place simultaneously in several countries. All of these must be taken into account in development activities.

In order for global science and technology co-operation to be profitable, it must be focused on those geographical regions and research areas that are particularly important to Finland, or in which there is particularly high-level competence or development potential in our country. This demands converging visions of the objectives from the entire field of research and innovation, as well as joint measures by the research organisations, financiers, and participants in business life.

One of the key issues of the so-called domestic internationalisation is how well we are able to widen the recruitment base of education and research, and attract new competence, investments, and (R&D-intensive) enterprises from abroad. Thus far, our success in this has been just adequate, which is demonstrated by the relatively small numbers of foreign students, researchers, and experts in Finland, and by our negative investment balance. However, it is true that direct foreign investments have not increased elsewhere in Western Europe either, with most investments having been made in Asia, the new EU countries, and Russia. Finland's technology, forest, and chemical industries have been particularly active in investing abroad. The majority of inward investments in Finland are channelled to services and ICT enterprises; the manufacturing industry's share of foreign direct investments has been less than 20 per cent. Of the overall research funding in Finland, a little over three per cent comes from abroad, which is among the lowest figures in the OECD. On the other hand, the proportion of funding from abroad for Finnish universities and research institutes is slightly above the European average and has been increasing favourably.

The process of globalisation has changed the relative strengths and positions of countries and country groups. The traditionally strong co-operation and market areas of Finland, Western Europe and the United States, are no longer self-evidently the core areas of dynamic growth. Enterprises have moved their operations to low-cost countries – particularly to the rapidly growing Asian economies – with adequate education and competence levels. Emerging economies develop their research systems and new technology in a determined manner.

The economic growth and competitiveness in the EU have not significantly improved in recent years. The EU has not been able to bridge the gap to the United States in these respects, nor in the quality or productivity of R&D activities. Neither is the EU perceived as being sufficiently attractive from the perspective of foreign experts and investments. The R&D investment balance of the EU is negative with regard to both the United States and Japan. For example, in 1997–2002 the negative research investment balance with the United States grew over fivefold, from €300 million to almost €2 billion.

The implementation of the EU research and innovation policy is still fragmented. In particular, there is room for improvement in the integration of SMEs in the EU projects and in their preparation. Development efforts are often unconnected; interdependencies between various measures are not adequately recognised, and synergy benefits are not attained. A more systematic and strategic approach should be taken to these issues through common visions and target-setting. In this respect, the authority of the Member States in relation to development issues is not to be weakened.

It is crucial to be able to promote the European Research Area (ERA) in such a way as to create a well-functioning internal market for research and innovation. The same applies to

the development of higher education at the European level. Fragmented resources in the EU area could then be used more effectively; the EU would be more attractive to enterprises, researchers, and investors from outside the area; exploitation of research results and production of innovations would become more effective; and favourable conditions would arise for multidisciplinary and cross-technological research. Through combining and networking the research and development resources of the Member States, improved quality, productivity, and competitiveness can be achieved to promote this development. The prerequisite is that the EU countries commit themselves to developing their innovation systems and co-operation, and to increasing research funding in accordance with targets set in Lisbon and Barcelona in order to create a true ERA.

In any case, the EU is the key and also the most natural framework of international co-operation for Finland. Topical issues for the future of the ERA are, for example, the launch of the Seventh EU Framework Programme on research at the beginning of 2007, the formation of the European Research Council (ERC), and recently initiated discussions about establishing a European Institute of Technology (EIT). Other promising features in the development of the ERA are the launch of the Competitiveness and Innovation Framework Programme (CIP), the founding of European Technology Platforms (ETPs), the planning and implementation of European Joint Technology Initiatives (JTIs), the ERA-NET operating model becoming more common, and the implementation of the European Information Society Programme i2010.

Strengthening of high-level research in Europe is crucial. It is in the best interests of everyone to improve European high-quality research, innovation abilities, and competitiveness.

> *In order to promote internationalisation of research and accelerate the development of the ERA, the responsible Finnish organisations must be more active with regard to EU research and innovation policy and research carried out in the EU. We must have the ability to introduce and support new initiatives. Finnish researchers and enterprises must increase participation in EU programmes to enhance important fields of research and our knowledge base.*

The business sector must actively participate in ETP and JTI measures that are important for Finland. At the same time, it is important for ETPs and JTIs to be linked to national and regional research and technology programmes. Success in this demands close interaction and a clear division of labour between domestic parties, reaching critical mass in core competence areas, and a successful mutually supplementing connection of competencies between various operative levels and programmes.

However, European orientation is not enough in itself. We need partnerships and co-operation with the best, regardless of their geographical location. It is essential for research and innovation and the policies supporting them to combine the global, ERA, and Baltic Sea region perspectives. Close integration into a global operating environment is necessary for the promotion of Finland's development and competitiveness and a prerequisite for Finland to bear the responsibility for common issues, such as environmental threats, health, security, poverty, and sufficiency of nutrition.

Responding to the challenges of global competition requires successful implementation of a national strategy emphasising competence and innovation. Simultaneously, it is a matter

of enhancing those competitive edges that are immovable or not as prone to copying as other modes of production. Human resources – particularly the creation of new knowledge, tacit knowledge, and special competencies – are still relatively location-specific. Thus, competence and its accumulation are local phenomena even in globalisation, which on its part emphasises the significance of high-quality innovation environments. Creation and consolidation of these environments are crucial for the success of Finland.

> *Improving Finland's ability to compete and co-operate requires clear prioritisation of activities, international profile-building by research organisations and enterprises, and development of selective decision-making processes. Development demands are directed at both the quality and the relevance of the activities. This requires a joint effort from all stakeholders of the innovation system: the ministries, financiers, research organisations, and business life. We must be able to create internationally high-quality and attractive competence clusters, research entities, and R&D units and programmes. This is also a question of the marketing and business competence that opens up new co-operation opportunities.*

Finnish enterprises have actively participated in the internationalisation of the economy. Investments abroad by industrial enterprises have grown rapidly in recent years. Approximately 40 per cent of the R&D of domestic industrial enterprises is carried out abroad. There has been no significant change in this figure in recent years. In this light, it would appear that Finland is still a favourable environment for R&D. However, retaining this position is challenging. On the other hand, Finland's presence in emerging markets – for example, in China, Russia, India, and the new EU Member States – has often been vital for retaining and, to some extent, even increasing productive activity in Finland.

> *Competence and experiences gained by Finnish parties abroad must be more effectively transferred back to Finland. This demand is directed both at the international activities of public research organisations and enterprises and at projects and structures supporting internationalisation of research and innovation environments.*

Examples of new internationalisation projects include the Asia Action Plan of the Ministry of Education (2006); the Finland–China innovation centre, FinChi, established in spring 2005 in Shanghai by the Ministry of Trade and Industry in collaboration with Finpro and Tekes; and the ongoing preparations for establishing innovation centres in California and St. Petersburg.

The significance of international infrastructures will continue to grow. We are a member of all of the major R&D organisations (CERN, ESA, ESO, etc.) based on intergovernmental agreements in the EU region. We also participate in the preparation of new European infrastructures in the ESFRI forum. There are also signs of increased activity at national level; for instance, the University of Helsinki has been assigned the task of preparing a plan for the establishment of the Molecular Medicine Research Centre. The aim is to create an international research centre that will be networking with the European Molecular Biology Laboratory (EMBL) and Nordic research centres working in the field. The operations of the new centre are expected to commence in the beginning of 2007. Co-operation between domestic biotech centres and other parties is further intensified by the new 'umbrella organisation' Biocenter Finland.

Opportunities offered by international organisations and projects and other European co-operation arrangements must be better exploited through collaboration between various administrative sectors and public and private organisations.

At the same time, various types of measures are being taken to reform the structure of European co-operation, to increase networking and mobility, and to promote research programme co-operation between the Member States. One key measure is to encourage the Member States to open up national research and technology programmes and funding to European competition. Finland participates actively in this development. However, we must proceed with care: the principles and rules for the activity must be jointly agreed on before opening up individual programmes and their funding. Some possible research areas have already been identified, and concrete progress in them can be achieved through the ERA-NET tool.

Well-functioning examples from Nordic research co-operation include graduate schools and Centres of Excellence in research. Corresponding interaction must be further developed in other fields, such as innovation, on the basis of mutual interests and national priorities. Nordic activities are becoming an increasingly integral part of wider research co-operation in the Baltic Sea region and other international frameworks, such as the Northern Dimension of the EU.

Internationalisation of education is inevitable, and it must be accelerated both in Europe and toward third countries by exploiting models and tools used in research co-operation, including joint interactive programmes. Moreover, it promotes integration of foreign nationals into Finnish society, their acquisition of necessary language skills, and exploitation of their skills in the economy and society. On the other hand, measures are needed also to transform higher education into a new and significant sector of the international service industry.

All in all, internationalisation forms a large area to be developed. It requires both that the domestic parties become more active and that they increase their mutual co-operation to promote internationalisation. Finland still lacks an active competence-based immigration policy and legislation that supports this policy. It must also be ensured that the special provision concerning the taxation of foreign key personnel and experts is continued. Promotion of these goals requires active measures from the science and technology administration.

Increasing mobility between (research) organisations and across sector boundaries both domestically and internationally is one of the key areas for development of the innovation system. While there is an increasing need for foreign intellectual resources in Finland, the number of Finnish researchers working abroad must be increased and the duration of their stays must be extended. In recent years, students' and researchers' willingness to go abroad has faded and Finns have not been very active in exploiting the mobility instruments provided by the EU. Finland's share of the mobility funding of the Sixth Framework Programme has been less than one per cent, while our share of the funding in the entire EU research budget is approximately 1.5 per cent. The number of foreign students coming to Finland has grown favourably, but, for example, the proportion of foreign students among all postgraduate students is still among the lowest in the EU. Recently, the University of Helsinki set the 2009 target for the proportion of foreign

postgraduate students at 15 per cent (in 2005, it was 9%). The working group for the development of doctoral education appointed by the Ministry of Education has proposed that the percentage of foreign students in graduate schools should be raised from the current just over five per cent to 20 per cent on average.

Numbers of visiting scholars have remained stable for the past 10 years. Most of the visits still last less than one month. It is a challenge for the universities and government R&D institutes to provide better prerequisites for inviting and receiving foreign experts. The matter at stake is, on the one hand, reform of personnel and recruiting policies and, on the other hand, for example, arrangements whereby research units can create long-term posts for foreign researchers in selected fields in collaboration with steering and financing organisations and parties in business life.

The Finland Distinguished Professor Programme (FiDiPro) launched by the Academy of Finland and Tekes is a new initiative to recruit international high-level researchers to work in Finland for a longer period than usually. Through the programme, it is possible to increase the scientific and technological competence of domestic research organisations as well as to create new international co-operation between academic and business R&D. The first call for proposals within the programme was promising; as a result, 35 proposals were selected for the second call. Once the programme gets under way, it is important to follow up on its effects and to continue its development. The overall impacts of the programme shall be evaluated by 2010.

1.6 Horizontal development measures

For a number of reasons, horizontal co-operation has become a key development object in science, technology, and innovation policy in recent years. The Science and Technology Policy Council discussed the dimensions and effects of horizontal co-operation extensively for the first time in its 1996 policy report. At that time, the focus was on development of the co-operation between science and technology policies and other policy sectors. As now, the co-operation was then seen to provide opportunities for new innovations and spreading of their positive effects throughout society. Co-operation also opens up new opportunities to find solutions to many societal problems.

The basic observation of the so-called *horizontal innovation policy*, which emphasises horizontal co-operation, is that innovations are created and introduced in various sectors and through actions taken by corresponding policy sectors, such as economy and business, labour, social and health, environment, and energy policy. This perspective emphasises co-operation at all levels, and through this the importance of governance is emphasised. The policy includes also facilitating access to research and other data for use in research performed in various fields.

The main tools for consolidating horizontal connections are *structural development measures* and *intensifying networking*. Both are clearly needed because this is not only a question of connections between science and technology policies and other sectors but also one of creating entirely new kinds of synergies between them.

> *Bringing previously separate activities closer together creates interfaces, which may give rise to new ideas, results, and innovations. The change presupposes*

the consolidation of co-operation among science, technology, and sectoral research, and the ministries responsible for these. Interdisciplinary and cross-technological approaches and the integration of social and technological innovation are key areas in horizontal co-operation to be strengthened through policy measures. International science and technology co-operation is an essential element of all horizontal activities. At system level, the development can be accelerated with co-operation among the Science and Technology Policy Council, the Economic Council, and the Information Society Council.

Social innovation is an entirely horizontal development area that permeates all sectors of society. In its previous policy report (2002), the Science and Technology Policy Council considered the drawing up of a development strategy for social innovations a clear challenge. In the Sitra (Finnish National Fund for Research and Development) research project on social innovations (2004), social innovation was linked to reforms in various societal structures, which improve the efficiency of the society. Social innovation changes the society's, the community's, or the individuals' way of acting, even though it may not be tangible in product and service markets. Significant technological innovations always have a social dimension – the significance of a social innovation becomes detectable when it is part of the change process of a larger system and is determined by its placement within the change processes. Social innovation in itself is seldom the object of business activities alone.

Research infrastructures are a key sector of horizontal co-operation. Joint use of infrastructures has to be intensified in respect of research instrumentation, research and field stations, national collections of data and other research material, and archives and libraries. For example, more open access to publicly funded research and register data has been a key issue for a long time. Both legislative measures and flexible contractual arrangements are needed for solving the problem.

1.7 Development of human resources

The number of research personnel in Finland has grown rapidly. Currently, almost 80,000 people are employed in the research sector, whereas 10 years ago the figure was less than 50,000. The increase is explained by increased research funding; the research volume more than doubled from 1995 to 2005. At the same time, the educational level of personnel has been improving steadily and the proportion of women in research has grown.

In Finland, the proportion of research personnel in the total labour force is the highest of all EU and OECD countries, at about 2.5 per cent. This is due to the very rapid growth in research activity within the information technology industry and the extensive higher education in relation to the population size. There has been a conscious effort to support this rapid growth with, for example, the systematic researcher education launched in 1995 (graduate schools), the Programme for Increasing Government Research Funding implemented in 1997–1999, the Programme for Increasing Education in the Fields of Information Industry implemented in 1998–2002, and the simultaneous LUMA project to increase schoolchildren's and teacher trainees' interest in studying mathematics and natural sciences. The Finnish comprehensive school system has also supported the

development, and it has been internationally recognised in the OECD's international assessments (the PISA studies).

The recruitment base for research is currently quite efficiently exploited. Thus, it is not possible to expand higher education, at least not purely with domestic resources. In the future, the declining number of young people will narrow this base even further. Therefore, the questions about quantitative planning of higher and vocational secondary education have become ever more pressing. The compatibility of education and work life must be improved at the national and regional level as well as at local level; labour shortage is still linked to a high level of structural unemployment.

We are dealing with a complex issue: to what extent the domestic recruitment base is sufficient to satisfy the labour needs created by the mass retirement of the baby boomers, the inevitable need for strengthening the development of the information society, and the concern over keeping the physical infrastructures of the society at an advanced level. It also remains to be seen what effect the free movement of labour in the internal market of the EU is going to have. Quantitative planning of both higher and doctoral education with regard to overall intake and field-specific intake also presents challenges. In some fields, the gender distribution of students and researchers has remained quite skewed and obstacles to women pursuing research careers have not entirely been successfully removed.

> *In order to strengthen human resources and to meet educational needs, it is necessary to widen the recruitment base, internationalise basic and postgraduate education, and improve the quality of education. The entire EU region must respond to these challenges so that the sufficiency of human resources and the renewal of researchers and other expert personnel can be ensured. Global competition for the best researchers and students is stepping up.*
>
> *Two-way internationalisation and increased mobility based on the high level of education and research are crucial to the development work. This requires new resources.*

Ever since the 1990s, Finland has sought to increase researcher education significantly, with quite a degree of success. The number of new doctoral degrees has tripled over the past 15 years. According to the Development Plan for Education and University Research adopted by the Government, the annual number of new doctorates is going to increase in the near future from 1,422 in 2005 to approximately 1,600.

Two thirds of PhDs, approximately 10,000 people, work in R&D. The majority work for the public sector and in particular universities, which employ 60 per cent of the PhDs engaged in research. In the universities, the number of PhDs has increased due to growth in research financed with external funding. In the future, it will not be possible to offer a post to all PhDs aiming at a research career in the university system; the aim is that increasing numbers of new PhDs could take up research and other tasks outside the university establishment.

In the 2000s, the *graduate school system* has been developed so that the training creates a strong basis for a professional research career and offers also versatile abilities to

perform demanding expert tasks outside the research arena. PhDs who have graduated from graduate schools have been employed outside the university establishment in enterprises, abroad, and in research institutes more often than other PhDs. Graduates from these schools are on average also significantly younger than other PhDs. Despite the Government target, graduate schools have not, at least not yet, become the most significant channel for obtaining a doctoral degree. The majority of PhDs still graduate through other channels.

The quantitative and field-specific need for doctoral degrees must be estimated when setting degree targets, allocating graduate school posts, and granting postgraduate degree rights of study. The Ministry of Education, the Academy of Finland, and the universities are responsible for quantifying doctoral study and field-specific intake. Allocation of graduate school posts cannot alone significantly affect the overall volume of PhD education or its field-specific distribution; the proper quantification of education and field-specific allocation are questions that must be solved in co-operation with all parties involved.

An international evaluation of PhD training (published in early 2006) presented special features of Finnish doctoral education (such as emphasis on the doctoral dissertation), deficiencies, and development challenges. The key message of the evaluation was that even though the graduate school system has increased the quality and efficiency of Finnish researcher education, the system is still in need of development. According to the evaluators, the system is fragmented and many of the graduate schools are too small and too focused on special areas. The schools should be larger, there should be fewer of them, and they should be nationally networked.

Graduate schools, like the doctoral education given at universities in general, should be tied to universities' centres of excellence, strong research areas, and the focal areas specified in the university research strategy. Graduate schools and teaching in them should be internationalised by forming joint PhD programmes with foreign universities and research organisations and by increasing the number of foreign students at the graduate schools. Work life skills provided in researcher education should also be developed further.

The working group report on the development of doctoral education (published in early 2006) proposes that the number of positions at graduate schools will be increased from the current 1,450 to 2,000 by 2012 and that the number of graduate school co-ordinator posts will also be increased. The proposal does not aim so much at expanding doctoral education as at ensuring that the number of PhD students gaining an opportunity to enter systematic doctoral education increases and that they thus receive better work life skills. In the future, careers in research will have to compete with other career alternatives, and this competition will get even tougher, as age groups are getting smaller. For now, researcher recruitment has been successful, but Finland also has to prepare for the situation already seen in several other countries, where this is no longer the case.

There are no real research careers in Finland; research organisations are office-based hierarchies. However, PhDs should have equal and as good as possible opportunities to both enter and advance in their research careers. Most of all, it must also be ascertained that we have high-quality and adequate research personnel to accommodate the needs of the entire research and innovation system in the future. The target set by the Government for research funding, four per cent of GDP, would mean a significant increase in research

activity and consequently an increased need for research personnel. The need for highly educated researchers is increased also by the target of raising the proportion of researchers with doctoral degrees among research personnel overall from the current 13 per cent to 20 per cent.

The *four-tier research career model* outlined by a working group appointed by the Ministry of Education offers a solution to these problems. In addition to universities and government R&D institutes, the research career model covers when appropriate the research careers in other sectors as well. The model is based on the parallel development of 1) financing instruments of the Academy of Finland, Tekes, and – as far as possible – various foundations and 2) of the staff structure of universities and research institutes. The starting point is to clarify the different stages of the research career, to simplify the nomenclature in all sectors, and to base advancement in a research career on external evaluation according to uniform criteria.

Doctoral studies are the first stage in the research career model proposed by the working group. The next stage is the postdoctoral research fellowship, which is followed by a stage as an academy or university research fellow. The fourth and the highest stage consists of posts of academy professor, professor, or research professor.

The implementation of the research career model requires structural changes supporting research. The above-mentioned research career working group considers it important to increase the size of university units. The objective is to have at least 5–10 professors in each institute. The universities must draw up clear education and research strategies and build their profile in core competence areas. Implementation of the strategies is based on an efficient and concerted use of basic funding and external research funding. As part of the implementation of the strategy, posts must be transferable from one field to another, taking the needs of education and research into account. The universities must commit themselves to more long-term support of talented researchers, which requires a willingness to take risks. The proportion of PhDs in government R&D institute and corporate R&D division staffing must be increased through an active recruitment policy.

The financing of the research career model is based on joint funding. It is the most effective way to pool the resources needed for the development of the new model. The model can be implemented mainly by exploiting existing resources and by allocating them efficiently. Core targets for additional funding are expanding the postdoctoral researcher system of the Academy of Finland, increasing the number of research fellow posts of the Academy, and creating new university research fellow posts. In addition, the Academy of Finland and the universities should jointly provide funding for the prolongation of research fellowship periods. The working group also proposed that the level of overhead costs paid by the Academy of Finland should be raised.

> *From the standpoint of research careers, the most serious problems are: repeated short-term employment of researchers, the difficulty in moving between sectors during one's career, the laborious combination of external research funding and career development, women's slow progress in research careers, the low level of international mobility, the small number of foreign researchers, the economic situation of researchers, and difficulties in quantitative planning of researcher education.*

The development of research career paths requires measures to ensure the attractiveness of the career, the development of postdoctoral research fellow education, and the improvement of the data and knowledge base on the research career. Statistics and estimates of the demand for PhDs are still incomplete with regard to both the four tiers of the model and field-specific quantitative planning. In order to follow up on the progress of the development work and the impact of the measures, it is necessary to establish a broad-based co-operative working group representing the expertise of the various parties involved.

1.8 Development of innovation dynamics

An innovation system functions well when it 1) ensures sufficient human resources and broad-based renewal of the knowledge base; 2) enhances the creation and accumulation of new scientific and technological knowledge and expertise, also bringing knowledge and know-how created elsewhere efficiently to the use of domestic parties; and 3) strengthens the ability to introduce and exploit knowledge and expertise, also promoting the production, dissemination, and commercialisation of innovations. The first two issues have been discussed earlier in this report. The discussion below concentrates on the third.

Improving the dynamics and functional capacity of the innovation system requires developing the system as a whole, not just through individual fields, organisations, or instruments. Improving the functionality of the system requires the structural and contentual development work presented earlier in this report and response to challenges in relation to internationalisation and horizontal activities – that is, the governance and co-ordination of activities. In addition, there is a continuous need to invest in quality and relevance as well as co-operation in science, technology, and funding.

A well-functioning infrastructure policy, particularly at a national scale, is an element that has rarely been pushed to the fore at policy level. However, this policy issue has become increasingly important both domestically and internationally. As mentioned above, the Science and Technology Policy Council has for its part accelerated the development in the field: the steering committee appointed by the Council has drawn up, alongside the national strategy on the Centres of Excellence in STI, guidelines for developing infrastructure policies.

An innovation system is as strong as its weakest sector. According to the EU Innovation Scoreboard 2005, Finland does not have considerable weaknesses. For example, the output of innovation corresponds pretty well with the volume of inputs in international comparison. However, the output does not yet sufficiently translate into new jobs or growth of GDP. According to the scoreboard, the special characteristic of Finland is that enterprises prefer to innovate by themselves rather than acquire innovations made elsewhere. This is seen as a weakness; that is, it seems that Finns are bad buyers and not so much poor sellers. A special challenge for Finland is also the fact that 57 per cent of enterprises (50% of industrial and 63% of service enterprises) do not carry out innovation activities. This figure is rather high internationally.

Ensuring favourable economic and societal development in increasing global competition requires us to be able to keep Finland attractive for business, in

terms of jobs, and as a living environment in general. Despite Finland's high-level competence and world-class innovation environments, the country's attractiveness as an investment target, particularly when it comes to industrial production and high technology, is still relatively weak. In these respects, we must redress the situation and turn our strengths into real competitive advantages.

From another perspective, our special challenge is to improve the quality of research and innovation as well as the overall functioning of the innovation system in a way that supports turning high-level and versatile competence into profitable business and new enterprises and jobs.

In order to respond to the changes of the economy and society, we must strengthen our competence base and specialise in selected fields. The question concerns sufficient investments in intellectual capital and its better use – i.e., improving innovation dynamics – and cross-sector development activities that help to achieve this objective. Improving innovation dynamics requires a joint vision of the key development needs and initiatives and measures supporting the vision. New kinds of co-operation models and tools, as well as structural changes, are needed to promote multilateral interaction.

Key policy challenges for politics in the promotion of innovation activities are 1) the intensification of interaction among the national, regional, and local levels and 2) the consolidation of the functional entity formed by these levels. At the same time, we must be able to connect domestic development activities to an international operating environment. The growing importance of creative innovation environments and the success of research-intensive centres have activated regions to develop their competence and innovation through local-level decisions and on the basis of regional competitive advantages. However, the links between national strategies and development actions arising from the regions' own needs are as yet insufficient. This is evidenced, for example, by the large number of public and private, national, regional, and local intermediaries providing innovation support services. A special challenge lies in the *creation of strategy processes* combining public and private parties and national and regional innovation environments.

We must ensure that development activities at regional and local level and the national policy are interactive and complementary to each other. The development of strategy processes supporting this aim should proceed simultaneously in many different directions, and not in a centralised manner steered by a single authority, organisation, or interest group. Core parties in the strategy process are the Ministry of Trade and Industry, the Ministry of Education, and the Ministry of the Interior. At regional level, the main parties are Employment and Economic Development Centres, Tekes, and the technology centres. Also, VTT – a research institute well connected to regional innovation environments – must participate in the processes. The same applies to regional and local, often private, parties and educational and research organisations.

Strategy processes help to improve interaction in a way that provides significant synergies, removes overlapping tools used by various parties, reduces the gaps between various players, and makes the use of resources more effective. Alongside this, the competence base of the intermediaries and the education

supporting it must be strengthened. In addition, impact assessment methodologies need to be developed.

The accessibility, efficiency, and impact of *public innovation services* (funding, education, guidance, internationalisation) must be improved considerably. The aim of development activities in the policy sector of the Ministry of Trade and Industry is to create common service models and units for different organisations. The Finnish Growth Company Development Service (Tekes, Employment and Economic Development Centres, Finnvera, Finpro) was launched in 2005 as part of the ongoing large-scale reform of the funding and service system. With these reforms we must ensure that R&D can be promoted in all regions and that the development measures cover the research and innovation potential of the entire country.

However, from the perspective of efficiency of public subsidies and proper functioning of markets, intervening in all stages of the innovation processes with public funding – for example, funding and guiding an enterprise from the seed and start-up stages all the way to the growth stage – is not warranted. Public measures must be limited more accurately than hitherto to areas with market failures and to situations where public organisations offer overlapping services to the market. After the above reform has been completed, its functionality must be continuously monitored. The impact of services must be regularly evaluated. The systematic knowledge base needed for the evaluation must be strengthened. In the near future, structural changes in the organisation of innovation services are also needed.

We must continue clarifying the division of labour and strengthening of co-operation between public and private providers of innovation services. They must be able to ensure the overall functionality and efficiency of their measures. The starting point is that the services are provided by the private sector and that the public sector creates a favourable framework for these activities. Public services supporting the transfer of knowledge and technology must be developed in order to correct market failures, on the one hand, and, on the other hand, to remove governance and systemic failures in the activities of the public sector.

In the development of the public innovation support system, particular attention must be paid to selected measures supporting internationalisation and promoting multilateral co-operation – i.e., market access abroad and internationalisation at home. Finnish researchers and enterprises must be encouraged to participate in this co-operation. For this reason, the Academy of Finland, Tekes, and Sitra, among others, have recently strengthened their interaction with Japan, China, India, Russia, and the United States. The universities and research institutes have continued networking and have in this way intensified their international co-operation.

Organisations supporting internationalisation must jointly co-ordinate their support activities and introduce demand-based measures with a view to strengthening both the research and innovation within the EU and co-operation with global high-level partners. In doing this, particular attention must be paid to enhancing SMEs' opportunities for participating.

The State Aid rules for research and innovation are based on EU legislation, which the Commission is currently reforming. The aim is to make the rules better correspond to the current nature of R&D and the support needs of competence-intensive (business) activities. The acceptable subsidies are to include activities that go further than the current rules allow into the area of innovation and enable more measures connected with launching programmes and clusters, exploiting competence and technology, and promoting mobility. *We must ensure that Finland takes full advantage of the opportunities to promote innovation provided by changes in the regulatory framework.*

Dialogue between the public organisations responsible for research and innovation policies and the business sector about development needs has progressed positively. The diversification and intensification of the co-operation is evidenced by various cluster-based development projects and the technology programmes of Tekes, which have been developed in collaboration with the customers to better meet their needs, to pay more attention to cross-technological orientation of activities, and to more broadly promote the prerequisites for innovation. Attention has been paid to developing services, increasing business, and marketing competence and internationalisation. Public actors have also paid more attention to the knowledge and competence needs of the business community and to increasing cross-sector partnerships.

The co-operation between the public and private sector can be intensified, for example, through various co-operation fora, research and technology programmes, centres of excellence in research, researcher education, and the forthcoming Strategic Centres of Excellence initiated by the Science and Technology Policy Council. The business sector's common vision concerning the development themes and needs would promote their interplay with the public sector. Therefore, enterprises should continue building joint cluster-based research agendas. In addition to domestic development work, this would support also participation in the European Technology Platforms and Joint Technology Initiatives as well as enhanced exploitation of their results.

The quality of research and the ability to exploit knowledge and expertise require adequate, long-term investments from both the public and private sector. Therefore, it is the aim of innovation policy to encourage enterprises to increase their R&D and to get increasing numbers of enterprises to undertake research, produce innovations, and commercialise them. Incentives, flexible structures, and a regulatory framework that promotes research and innovation are needed alongside investments.

The *impact* of public funding by such parties as Tekes and the Academy of Finland has been assessed to be positive in relation to the R&D of business enterprises and research organisations. Unlike in many other countries, in Finland enterprises receiving public R&D support have themselves invested more in research. This has been one reason to increase public research and innovation funding. In addition to the effects on funding and the indirect and business results achieved, enterprises receiving funding have often also changed their operating methods and behaviour in such a way as to increase the significance of education and research as well as the ability to exploit new knowledge and expertise. The multiplicative effects of knowledge and know-how spreading more broadly into the operational environment will further increase the overall impact of subsidies. However, increasing attention must be paid to the functioning of *activating measures* and *incentive mechanisms*. We must be better able to assess the added value to research and innovation created by incentives and whether measures lead to the desired results.

Tax incentives are widely used in OECD countries, but they have hardly been used in Finland. According to international comparative surveys, a better overall effect and economic efficiency are reached with a diverse set of R&D support measures than with general tax incentives. However, there are development areas in which the possibility of using tax incentives should also be studied. Particularly when it comes to *technology companies in the seed and start-up stages,* there are gaps in funding. The situation could be improved with incentives for private capital investors, such as reducing the tax burden on yield from investments in new technology enterprises insofar as the yield is invested again in similar start-ups.

Funding and other support for start-up technology-intensive companies requires co-operation from the entire system. One actor cannot succeed in it alone. Research-based enterprises that have received public innovation funding do not often succeed in developing their operations with the funding to such an extent as to make them attractive also to private financiers. Public funding is not optimally used if development activities are abandoned before they can attract wider interest. Furthermore, an enterprise should not be founded prematurely – for example, in a lengthy research stage that demands capital investments or in a situation where starting profitable business activities in the near future is not realistic. The overall situation of start-ups is worsened by investors' inadequate risk-taking ability, yield requirements that are too high for the capital invested, and investment of limited capital in too many targets.

> *More attention must be paid to the imperfections of the financial market, the division of labour, and issues of co-operation between public and private risk financiers and capital investors. Public financiers have concentrated especially on seed-phase funding whereas private investors have concentrated on funding enterprises' growth phase and corporate acquisitions. Different development stages of enterprises and subsequently differing financing needs have not been comprehensively taken into account. We must deal with the gaps and other imperfections in the funding system by means of co-operation between service providers and by developing the competence of intermediaries.*
>
> *In order to ensure sufficient funding for start-ups and growth companies, the possibilities for introducing incentives directed at private capital investors – including reform of taxation to favour (re)investment and to improve technology-intensive enterprises' opportunities for attracting funding from the financial market – must be examined.*

The volume of *direct foreign investments* to Finland has been comparatively low. It is important to increase these investments so that investments made by Finnish enterprises and capital investors abroad can be compensated and that Finland's investment balance does not permanently remain negative. Particular attention must be paid to the regulatory framework and to measures via which more investments creating new business based on high-level competence, research, and innovations are channelled into Finland. National co-operation and networking must be made more effective to intensify internationalisation. The agencies promoting internationalisation (Finpro, Invest in Finland, Tekes, Sitra, the Academy of Finland, VTT, etc.) should jointly invest in reinforcing two-way international co-operation.

Creation of well-functioning, *innovation-friendly markets* is a means to support research and innovation, to make exploitation of results in the form of new research initiatives or business opportunities more effective, and to improve productivity and well-being. Key tools in this are public procurement and its development, particularly in a way that enhances research and innovation. This can take place simultaneously with other measures that activate innovation within the business sector.

The overall value of *public procurements* is considerable, over €20 billion. Some of the acquisitions are such that the public sector could more often function as a demanding customer, a mediator between customer groups, or gather different interest groups together in a way that promotes co-operation. Promoting research and innovation through public procurement requires developing procurement criteria and incentives as well as increasing the acquisition competence and co-operation of the responsible actors. It also requires the creation and implementation of new operating models supporting procurements. Potential application areas include, in particular, welfare services, energy and the environment, and infrastructures – particularly communications, transport, and construction. At the same time, we must evaluate the functioning of current instruments with regard to innovative procurements and identify the fields in which procurements could have a positive effect. The EU is currently specifying best practices in public procurements and promoting their implementation. Finland must closely participate in this process in order to be able to better evaluate possibilities offered by this incentive mechanism that have been overlooked so far.

In order to increase the dynamism of the innovation system and the impact of research and innovation, it is necessary to focus development activities on promoting *entrepreneurship* and growth-oriented enterprises. In particular, the number of start-up technology companies must be increased because they are important with regard to the national economy; these companies diversify the business sector, they are efficient at adapting new technologies, and they often also grow rapidly and thus create new jobs. According to surveys, *growth-oriented entrepreneurship* in Finland is at best average in international terms. Of approximately 1,500 to 2,000 knowledge- and innovation-based business ideas identified each year, not even one in 10 proves to be worthy of seed funding and only a small percentage of these actually ever receive risk financing. Furthermore, only a few of these finally prove to be growth enterprises.

Higher education graduates are not that interested in founding their own business. However, regional and field-specific differences are great. For example, people who have graduated from a university in the greater Helsinki area in 1999–2002 are on average twice as likely to have become entrepreneurs as those who graduated elsewhere in the country. When it comes to polytechnics, the situation is exactly the opposite. The least interest in becoming an entrepreneur is displayed by those who have degrees in engineering and technology. The usual route to entrepreneurship runs through paid work with experience and educational background affecting the decision.

The education level of entrepreneurs has been on the rise for some time. However, the attitudes and the atmosphere are still not optimal; failure is met with a very negative stance. Higher education institutions have increased training that promotes business know-how and entrepreneurship. Steps in the right direction include measures promoting entrepreneurship training taken by the Ministry of Education, universities' entrepreneurship strategies and the incorporation of training that increases knowledge of entrepreneurial

activities into the basic study curriculum, and the Government's Entrepreneurship Policy Programme. Students and employees must be encouraged to try out various career alternatives and various forms of entrepreneurship, and to combine entrepreneurship with paid work. Education and guidance play a significant role in this. In order to promote entrepreneurship, attention must also be paid to measures directed at entrepreneurs as individuals and not just at the enterprise as a whole.

> *The need to promote entrepreneurship among higher education graduates has to do with improving education and guidance and with promotion of the general entrepreneurial atmosphere and business competence. Measures supporting entrepreneurship should be focused also on the regulatory framework (competition and work legislation, employers' obligations and salary issues, bankruptcy practices), issues of livelihood (social security and taxation), and funding of business activities, with particular attention in all of these areas being paid to the needs of research-intensive enterprises.*

The service sector accounts for over 70 per cent of GDP. Of this, the share of private services is approximately two thirds and the rest consists of public services. The increasing importance of services to the national economy, employment, and productivity means that their all-round development in both the private and public sector is increasingly important. In particular, the development of knowledge-intensive business services has to be a core development target. Research and innovation carried out in the service sector in Finland are relatively modest.

The R&D intensity in the service sector is considerably lower than in industry. In Finland, the share of services in the overall R&D expenditure is approximately 20 per cent. This is half of the share in the United States but still clearly above the EU average. The R&D expenditure in the service sector has risen more rapidly than in industry during the 2000s. However, only four fields contribute to this growth: data processing, research and development, technical services, and some knowledge-intensive business services. Only a little over a third of service companies engage in innovation activities. Moreover, they co-operate with research organisations less than other enterprises.

In international terms, the industrial sector's share of the economy and employment in Finland is high. An increasing percentage of industrial enterprises also perform service business, and an increasing share of their turnover comes from services linked with products and processes. Continuing positive development requires that industrial and service companies strengthen their research and innovation and create joint operational strategies and models. In this respect, the traditional separation between industry and services is no longer relevant with regard to developing the business sector.

Innovation in services often combines technological and social innovations. The latter are connected with, for example, the intensifying producer–user relationships and the development of structures and new operating models supporting them. Extensive exploitation of existing technologies, such as ICT, is also crucial because it makes possible the implementation of novel co-operation, operation, and management models. The public sector has a special duty to support the creation and commercialisation of innovations, and to create new collaborative platforms for these activities.

All in all, at issue is promoting innovative services throughout the entire business sector in a way that supports the creation of new products and improves both the productivity of services and international competitiveness, as well as business competence and management. Among others, Tekes has recently tackled these issues by launching new technology programmes. In the programmes, an essential feature is that the development of technology and business competence is advanced in an integrated manner. Ensuring access to the necessary knowledge and expertise requires also sustained research into services, generation of critical mass, and attainment of a top international level for research in key areas.

Promotion of mobility of higher education graduates is crucial to the functioning of the innovation system and the dissemination of knowledge and expertise. Tacit knowledge and competence are most effectively transferred when an employee moves from one workplace to another. Several science and technology policy measures promoting mobility have recently been implemented in the EU and OECD countries. We must be able to increase mobility at all levels of the system, particularly across sector boundaries. The mobility rates, particularly between universities, research institutes, and the business sector, should be considerably higher than it is currently. Personal contacts between enterprises and universities born out of research co-operation and contracted research must be better exploited.

Mobility across sectors can be promoted in various ways, which have not yet been sufficiently exploited in Finland. These include: long-term commitment by enterprises to university activities and increasing co-operation in education; increased teaching performed by employees of enterprises at universities; mobility support programmes to promote hiring of university graduates in R&D in enterprises (particularly SMEs); researcher sabbaticals, which could be used for working in enterprises; researcher education and research programmes tailored by research organisations to employees of industry; and agreements between enterprises and universities on fixed-term researcher exchange programmes – for example, fixed-term posts for employees of industry in universities and research institutes.

> *International mobility must be increased alongside domestic mobility. Mobility should be supported by increasing the resources devoted to it; creating incentives; and more actively exploiting international, particularly EU, mobility instruments. Crucial factors are universities' and research institutes' own activeness, the establishment of long-term partnerships, and the introduction of sustainable financing solutions supporting mobility.*

Wide-ranging promotion of innovation dynamics, development of science and technology policy tools, improvement of the productivity and impact of the measures, and selective decision-making all require promoting and increasing competence connected to *evaluation activities* and *foresight*.

> *Assessment of the impacts of public measures sets new challenges for the development of evaluation and foresight. For example, more attention must be paid to the actual scope of impacts, especially the long-term effects and complex impact mechanisms of public R&D and innovation subsidies both in innovation research and by financing institutions. The Academy of Finland and*

Tekes have a central role in promoting this work, together with ministries and experts as well as public and private research institutes.

Foresight activities have increased considerably in recent years. By applying foresight, we have to some extent managed to remedy previously perceived deficiencies, such as fragmentation of activities and the lack of a systemic approach. Currently, core projects in this area are the Government Foresight Network, the Foresight Forum of the Ministry of Trade and Industry, and the National Foresight Network launched by Sitra.

FinnSight2015, an extensive foresight project co-ordinated by the Academy of Finland and Tekes, was completed in June 2006. The project was organised into 10 panels dealing with the following themes: learning and learning society; services and service innovations; well-being and health; environment and energy; infrastructures and security; bio-expertise and bio-society; information and communications; understanding and human interaction; materials; and the global economy. In all, the panels identified over 80 areas of competence. Through investment in these, breakthroughs in science and technology and new innovations can be reached in Finland.

Wide-ranging development of foresight from the perspective of research and innovation should be continued. Adequate resources must be allocated to foresight, and the commitment of participants to the projects must be consolidated. Close connection between foresight and decision-making is essential. This presumes that the results are of high quality and in an easily exploitable form. Internal and cross-sector co-operation of administrative sectors must be intensified. In particular, the prerequisites for cross-sector foresight must be consolidated. There is still need for a comprehensive national project where science and technology foresight is integrated into a wider societal and economic perspective.

2 Development programme 2007–2011

Finland's strategy is to ensure sustainable and balanced societal and economic development. Determined development of knowledge and expertise and their quick and flexible exploitation are core prerequisites for the implementation of the strategy. This requires further investments in science, technology, and innovation.

However, it is clear that need- and demand-based activities must be strengthened alongside supply-based development. Thus we can increase the positive effects of research and education investments and promote employment, productivity, and competitiveness. Several global developments affecting all countries constitute the background to the demand. Finland has identified *increasing internationalisation both domestically and abroad, continuous change of business and social structures, competitive factors affecting innovation dynamics*, and *the ongoing changes in R&D* as trends. A special feature of the Finnish society is an ageing population. These developments present a variety of challenges that must be answered. We need to respond to the challenges in order to secure favourable development of the economy, society, and culture, as well as the well-being of the population and the environment. These needs lead to a demand for a *near-future development programme for science, technology, and innovation policy, one that combines contents, funding, and structures*.

Funding sets the financial framework for the development programme. Based on decisions made by the Government in 2006, the R&D funding for the near future appears as follows:

R&D financial statement:

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Government, € million	1,595	1,680	1,700	1,800	1,900	2,000	2,100
Total R&D investment, € million	5,400	5,720	5,940	6,250	6,620	7,000	7,250
R&D, % of GDP	3.50	3.55	3.60	3.70	3.85	4.00	4.10

The figures are based on the following starting points:

1) Government framework decision of 21 March 2006

2) Government strategy document decision of 20 April 2006

3) GDP growth assessments / Ministry of Finance, 23 March 2006

4) Additions for 2007–2011 based on value of money in 2006

Increasing research resources in accordance with the Government framework decision by five per cent annually from 2007 to 2011 would mean an annual increase of approximately €100 million in public research funding in this time. If the target for the growth of national

research investment, set at four per cent of the GDP, is reached by the end of the decade, as the Government has demanded, the share of public research investment will just about remain at the current level, close to 30 per cent. However, it is crucial for the realisation of the overall target that funding from other sources, particularly Finnish enterprises, will develop. It is the duty of the government to create and maintain basic conditions for research and innovation and to develop operating environments to enable reaching the overall goals.

Reaching contentual and functional goals is not possible merely by increasing investments. When compared to the size of the national economy, Finnish investment in R&D, particularly after the recession of the 1990s, has been considerable. However, increases have been partly allocated in a way that scales up the fragmentation of the national research system. Partly inappropriate distribution of resources has led to a number of small, overlapping units with not enough top-quality material or intellectual resources. Units have only limited chances to participate in international research co-operation that requires larger co-operative entities. It is vital that fragmented resources be pooled so that even large-scale and demanding research tasks can be tackled either nationally or through international co-operation.

Thus, funding issues discussed above are connected to the development of *structures*. The Government resolution of April 2005 required that numerous measures combining funding and structures be implemented. Public research investors must develop their mutual collaboration and co-operation with private and foreign financiers in order to create and enhance top-level competence clusters. The Academy of Finland and Tekes, together with Sitra and other financiers, must develop their financing and other co-operation in order to improve the impact of research and innovation funding and to create larger operational entities. Financiers need to review their procedures and funding instruments and, if necessary, develop new ones, particularly with a view to promoting interdisciplinary and cross-technological research and to attracting foreign world-class experts to Finland. Under the leadership of the Ministry of Education, the higher education system will be developed in a way that ensures and promotes the impact of the units' activities, and their quality, content, and effectiveness. To this end, resources shall be allocated for creating larger entities, promoting networking, and making management and evaluation of activities more effective. Direct budget funding of universities must also be allocated for renewing the structures and universities' own steering systems. Competitive funding must be increased in order to support the renewal and specialisation of higher education institutes. The ministries must increase their uncommitted research funding and develop funding and other co-operation with the Academy of Finland and Tekes. Research institutes have to acquire more external research funding and increase its share of their total R&D financing. Basic funding for VTT in the selected focal areas important to Finland must be increased.

All of these views, as expressed by the Government, aim at getting the funding for science, technology, and innovation; the funding mechanisms; and the structures of key educational and research organisations to correspond to each other and to get them to fully support the contentual targets set for R&D. Co-operation between financiers and pooling of resources is one clear line of development. Another is developing the structures, financial governance, and management of research organisations in such a way that the *central contentual target* of the Government resolution is reached – i.e., world-class R&D in the fields that are most significant for the national economy, societal development, and the citizens' well-being.

The implementation of most of the above-mentioned items of the resolution has progressed. The most critical part from the perspective of the entire public research system is structural reform of the higher education system so that it can function fully as a high-level element of the national innovation system and the international education and science community. Renewal must be accelerated with performance-based steering and other means of funding and structural development, including increasing universities' and polytechnics' opportunities and encouraging self-initiated development activities.

In addition to top international quality, *the core criteria* for developing contents are a need-based and customer-driven approach (i.e., relevance) and the availability and organisation of material and human resources in a manner that corresponds to quality and relevance requirements. As for the material resources, modern infrastructures and their international competitiveness have become core elements alongside the funding issues. *Thus, the development of contents from the perspective of resource allocation is divided into three parts: identification of key areas for development, choice of appropriate funding instruments, and ensuring of appropriate infrastructure and other basic prerequisites.*

In the coming years, we must be able to allocate resources in a more focused manner. One of the most significant new forms of co-operation between the public and private sector will be the *Strategic Centres of Excellence scheme*. The centres are international top-level competence centres for science, technology, and innovation (STI) in fields that are crucial to the future of the business sector and society. The Science and Technology Policy Council has identified five subject areas in which concrete measures should be taken. The areas are: *1) energy and the environment* (e.g., environmentally friendly energy production), *2) metal products and mechanical engineering* (e.g., moving machinery and vehicles as well as manufacturing and automation technology), *3) the forest cluster* (e.g., comprehensive exploitation of materials such as wood and its derivatives as well as intelligent products), *4) health and well-being* (e.g., well-being of the elderly and development of individualised medical care and diagnostics), and *5) the information and communication industry and services* (e.g., services and products of the future information society). The Ministry of Education and the Ministry of Trade and Industry will appoint a steering group to supervise and evaluate the implementation of the strategy.

The Strategic Centres of Excellence in STI also call for new kinds of funding mechanisms for Finnish R&D and innovation. The centres deal in research that anticipates the needs of society and the business sector over a time span of five to 10 years. This in itself demands a new kind of commitment from enterprises, universities, research institutes, and funding organisations participating in the centres. The participants must have a clear shared vision and a focused strategy. The level of commitment to the centre may vary, which means that there are different levels of opportunities to affect the direction of the activities. In the general model of the centres, the core group of a centre will found a so-called non-profit limited company.

In parallel to the centres, it is important to reinforce such important and promising fields as biotechnology, new materials, nanotechnology, software engineering, and knowledge-intensive services. The synergy between the Strategic Centres of Excellence and the new Centre of Expertise Programme to be launched in early 2007 must be properly ensured. This shall be done primarily through co-operation between the technology administration and the steering organisations for regional development.

Another important new funding instrument is FiDiPro, the already-mentioned joint programme of the Academy of Finland and Tekes to attract world-class researchers to work in Finland for two to five years. Funding is applied for by a Finnish university or research institute, which emphasises the programme's goal of building the profiles of these organisations.

The aim of the FiDiPro programme is to reinforce the highest level of scientific research carried out in Finland. Alongside the direct investment in top-level researchers, the creation of a genuine research career system in Finland requires long-term investments in different stages of the research career – i.e., the postdoctoral and independent researcher stage and the pre-professorship level. Implementation of this four-tier research career model outlined by the Ministry of Education's research career working group requires determined measures. The most urgent of these are increasing the number of posts for so-called independent researchers in the Academy of Finland and the universities and developing the personnel structure of universities in a way that promotes the implementation of the research career model.

In allocating resources, a new kind of attention must be paid to the development of infrastructures of a national scale. Finland has lacked both a national infrastructure policy and mechanisms that are flexibly suited to the evaluation and funding of these kinds of infrastructures. It is necessary to take urgent measures to catch up with other countries in this respect. An infrastructure development programme prepared by the Science and Technology Policy Council provides a basis for the future activities. According to the programme, in the first phase the most important and topical item is to chart the current national-scale infrastructure, the needs for its renewal and development, and the needs and opportunities to exploit international infrastructures. This work is also closely connected with the promotion of internationalisation within Finland. For the basic work, the Ministry of Education and the Ministry of Trade and Industry have to appoint an expert group, which would also assess long-term needs and comment on new infrastructure projects. The group will be composed of representatives from the public and private sector.

In summary, this all means that future resources and those existing resources that can be reallocated after reforming of structures and activities should be primarily directed at the following targets:

Increase in public research funding, 2007–2011

Increase in the level of funding from 2007 to 2011 (in 2006 monetary value; € million), itemised by use and by organisation, is as follows:

Increase by use	
Strategic Centres of Excellence in STI	130
Infrastructure	20
Development of research careers	50
Development of graduate schools	15
Raising the overhead costs used by the Academy of Finland	20
Increase in competitive research and technology funding	60
Increase in research funding included in universities' basic funding	60
Research and education in technology	20
Sectoral research, including basic funding for VTT	25
Total	**400**
* The figure is based on an accumulated 4 x €50 million increase in 2008–2011. Of this, 30% is calculated as being allocated to research	
Increase by organisation	
Academy of Finland	110
Finnish Funding Agency for Technology and Innovation, Tekes	145
Universities	120
Ministries and research institutes	25
Total	**400**

Table. Global environment of the Finnish STI policy: challenges, drivers of change, and opportunities.

Strengths	Opportunities and means
- Finland having become an active partner in international co-operation quite recently but rapidly; a very high rate of participation in the activities of international organisations - Science and technology policy implemented on a long-term basis; investment in R&D regarded as important - Well-functioning education, research, and innovation systems - Openness, intensive co-operation, and competitiveness of the innovation system - A high proportion of competitive R&D funding - A high level of education among the population - Brain drain relatively small - A high proportion of women among researchers and PhDs by international standards - A large number of researchers, who make up a large percentage of the employed - Research volume, quality, and impact at a good international level - Active international patenting - Finland's good reputation: reliable, safe - Knowledge-intensive businesses remaining in Finland - Good co-operation between business enterprises and public research - Finnish enterprises being internationally networked	- Effective and efficient national innovation environment boosting competitiveness ↔ internationalisation of the activities and organisations of the innovation system - An enhanced knowledge base and R&D environment, attracting new foreign investments and intellectual resources to the country and improving Finland's position as an attractive region for business operations - Looking for competence where it is best: global and diverse international co-operation, going beyond the EU - Compensating for the small size and geographical remoteness with active, strategically sound co-operation - Prioritised pooling of limited, fragmented resources - Open-minded and sufficient support for creativity and innovation - Enhancing foresight activities and their linkage with decision-making and strategic steering - Implementation and productisation of social innovations - Enhancing positions in international co-operative institutions and R&D organisations - Improving the organisational and functional structure of the innovation system and the division of tasks - Developing business and marketing competence - Creating a favourable business environment and promoting entrepreneurship - Supporting the creation and growth of businesses that focus on R&D and exploitation of leading-edge expertise
Weaknesses and framework conditions	**Threats**
- Strong dependence on global trends - Remote location from global market centres, geographically distant from the centres of Europe - Difficulties in relation to attractiveness and growth: a small domestic market area, a limited number of inhabitants, a small language area, and severe climate - A relatively low level of internationalisation by European standards - Limited economic and intellectual resources: a low volume of knowledge and competence in many fields and the cutting edge of scientific research in the hands of a select few - Problems with venture capital (amount, availability, matching of demand and supply) - Deficiencies in marketing and business competence and in knowledge and innovation management - A small number of spin-off businesses from universities and research institutions - Fragmented research activities: resources allocated to a large number of small units - A small number of highly educated foreign experts, students, and researchers - A small number of growth-oriented enterprises - Enterprises and parts of their operations moving abroad - Low inflow of foreign direct investments; negative balance of investment	- There is an international economic recession and decline in Europe - Finland does not attract foreign direct investments, R&D investments, researchers, and students - Finland is less active in the EU and global R&D co-operation - The operational foundations of the EU become weaker: more internal conflicts and less commitment and co-operation - National interests are overemphasised in international co-operation - Focus is missing: participation in too many projects with scarce resources - Links among research and economic development, employment, well-being, and innovations grow weaker - Diminishing age groups and an ageing population undermine the balance of the public economy, the room for economic manoeuvring, and the supply of highly skilled labour - The regulatory framework does not support the transfer of research results from R&D organisations to businesses and the commercialisation of results - Availability of competence in the labour market is insufficient: education does not meet labour market needs - The number of new R&D-intensive businesses declines - The favourable development of public R&D funding stagnates - Business R&D expenditure starts to decline - Businesses increasingly move their operations abroad - Brain drain increases: high competence moves abroad

APPENDIX 1

THE SCIENCE AND TECHNOLOGY POLICY COUNCIL OF FINLAND 2003–2005

The sixth term of the Science and Technology Policy Council of Finland began on 1 March 2002 and ended on 28 February 2005. In this time, the Council convened 11 times. The Council that started its term on 1 March 2005 convened four times during 2005. There have been four special items: the strategy document 'Internationalisation of Finnish Science and Technology' (see Appendix 2); the joint meeting with the Estonian Research and Development Council in Helsinki on 26 May 2004; the special meeting on the state and quality of scientific research in Finland on 7 November 2003; and the evaluation of the structures of the public research system, on the basis of which the Government made a resolution on the structural development of the public research system (see Appendix 3). The science policy subcommittee of the Council convened 25 times, as did the technology policy subcommittee.

As part of the implementation of the resolution, a new decree concerning the Council was passed on 27 October 2005. It came into force on 1 January 2006. The term of the Council was changed to correspond to the electoral period, which is normally four years. The key sectoral research fields are to be emphasised in appointment of ministerial members to the Council. Other changes made were the abolition of the working committee of the Council and the strengthening of the capacity of the Council secretariat. The new decree can be read in its entirety in Appendix 4.

Permanent tasks of the Council include: 1) development of research and innovation funding; 2) development of human resources; and 3) international science, technology, and innovation policy. As for research funding, it is worth mentioning that the volume of funding has been increased for 2003–2006 in accordance with the Government's budget framework decision made in 2003 and covering the entire electoral period until 2007. The increase is based on the recommendations presented by the Council in its previous policy report, in December 2002.

APPENDIX 2

Science and Technology Policy Council of Finland
12.11.2004

INTERNATIONALISATION OF FINNISH SCIENCE AND TECHNOLOGY (SUMMARY)

Finland will ensure her success on a global scale by strengthening the knowledge and competence base, investing in high-quality education and research, developing production and corporate structures, enhancing international marketing and business competence, and enhancing innovativeness and the utilisation of knowledge. Finland's research strategy is built on the present strengths and the need to create new ones through systematic and continuous development of knowledge, competence, education, research, and innovation. The underlying principle in extensive international co-operation is high quality and relevance.

The *objective* of the strategy is to:

- support Finland's own development and competitiveness and increased responsibility for responding to global problems and challenges
- support sustainable development of the economy and the environment, as well as promote employment, well-being, social cohesion and cultural diversity
- enhance the integration of the Finnish innovation system with international science, technology development and innovation
- combine global, European and national perspectives in a balanced manner in the development of research activities and innovation system
- promote internationalisation within Finland and participation in the different forms of international research co-operation: official and informal, multilateral and bilateral
- increase the number of high-competence jobs and the volume of research in Finland.

Finland's position as a knowledge-based society and a reliable and recognised partner will be strengthened. Finland's *strategic choices* in support of these objectives include:

- continuous developing innovation environments with a view to high-quality research and innovation
- strengthening the international competitiveness of the business enterprise sector and improving the preconditions for co-operation particularly with the world's leading R&D centres
- increasing the attractiveness of Finland for foreign investments, world-class infrastructures, foreign and multinational enterprises, new business activities, and foreign experts, researchers and students
- actively strengthening research co-operation in the Northern regions and the Baltic Sea region
- influencing the direction and objectives of research within the EU in a systematic and target-oriented manner

- promoting the position of research and increases in research funding in the EU
- ensuring that:
    - the primary goal of EU research is to support the realisation of the Lisbon strategy
    - EU research funding is always targeted at European added value
    - EU actions promote multilateral networking, co-operation, as well as the creation, dissemination, application and implementation of new knowledge
    - EU increases and diversifies its co-operation with third parties (countries, organisations)
- promoting business enterprise participation in European R&D co-operation and the utilisation of its results
- strengthening the position and funding of high-quality basic research in Europe.

Essential *means* for achieving the objectives include:

- increasing public research funding on a long-term basis, continuously investing in education, and strengthening and diversifying our knowledge base and infrastructure
- alleviating the fragmentation of the research system with a view to creating and developing research units that are large enough for international co-operation
- exercising prioritisation, specialisation and selectivity at all the levels of the system, as well as strengthening the strategic decision-making and developing measures in support of these
- systematically developing an internationally competitive, high-quality knowledge base and Finland's strengths to improve the preconditions for co-operation with leading global partners
- including internationalisation-related aspects in all decision-making concerning education, science, technology and innovation
- promoting networking within R&D and innovation in Finland and internationally both within research fields and between them
- the government and other public sector agencies adopting a proactive role in promoting internationalisation, particularly in the preparation of measures associated with EU research and innovation policies and other international affairs
- intensifying co-operation between the public and private sectors with regard to the enhancement and utilisation of internationalisation and the strengthening of infrastructures
- improving the ability to anticipate changes and new phenomena and the opportunities opened up by these
- integrating foresight activities into decision-making and strategic steering of research and innovation policies
- removing obstacles to and restrictions in international co-operation and mobility, through amendments to legislation where necessary, and reformulating recruitment policies and developing research careers.

APPENDIX 3

Government
7.4.2005

GOVERNMENT RESOLUTION ON THE STRUCTURAL DEVELOPMENT OF THE PUBLIC RESEARCH SYSTEM

The national objective for Finland is a sustainable and balanced societal and economic development. High employment, productivity and competitiveness are key factors in it. Focused measures to step up research and technological development and the utilisation of their results play a significant part in this. These also have an important place in efforts to respond to challenges facing culture and the environment. The structural development of the public research system will support the achievement of the objectives in a constantly changing international operational environment.

The systems level

1. The public research system will be developed as an operational entity on the current basis with a view to continuous development of the quality and relevance of research and development. The development measures will be targeted to boost the prioritisation of activities, the international and national profilisation of research organisations and selective decision-making resting upon foresight. A crucial challenge is to develop world-class R&D in fields most relevant to the national economy, to societal development and to the citizens' well-being. The responsibility for implementing the development measures always rests with the organisations which these development needs concern. Global development, the emergence of the European Research Area (ERA) and intensified cooperation in the Baltic Sea Region entail that particular attention is attached to international science and technology cooperation.

2. The public research funding organisations will enlarge collaboration amongst themselves and with private and foreign financiers in order to strengthen and increase knowledge clusters of the highest standard. It is important that the core funding of research organisations and competitive funding complement each other in a balanced way. Measures will be taken to increase the joint projects of higher education institutions, research institutes and companies and to intensify infrastructure and other cooperation with a view to developing the operation of the research system and promoting research-based social and technological innovation.

3. The internationalisation of education, research and innovation is a central development goal for the research system as a whole. International communication about the cooperation opportunities offered by Finnish science and technology will be improved, and internationalisation in Finland will also be promoted by legislative means. Measures will be taken to enhance the possibilities, capabilities and mechanisms of all the players in the

research system for receiving foreign researchers and other specialists. The Ministry of Education, together with other ministries, will take action to develop the intellectual resources required by this Resolution and to promote research careers.

Decision-making and steering organisations

4. Once every electoral period, the government will arrange an opportunity for Parliament for a comprehensive discussion on science, technology and innovation policy based on the Development Plan for Education and University Research adopted by the Government and the policy review published by the Science and Technology Policy Council once during each term of office.

5. The links between science, technology and innovation policy advice and political decision-making within the Government will be strengthened. The Cabinet Committee on Economic Policy will discuss the major questions also in these sectors on a preparatory basis. The Minister of Education will participate in the Committee's decision-making when it discusses these issues. Possible other arrangements will be made at the change of the electoral period.

6. To the same end, the Science and Technology Policy Council will be developed as the principal expert body in all major questions of science, technology and innovation policy. The term of the Council will be extended to four years and the Council will be assigned a full-time Secretary General attached to the Ministry of Education. The foremost sectoral research fields will also be taken into account in the composition of the Council.

7. The role of science, technology and innovation policy will be strengthened in the Ministry of Education and the Ministry of Trade and Industry, especially with a view to developing national horizontal cooperation and internal cooperation in their administrative sectors. The corresponding development measures to be taken in sectoral research under the ministries and inter-ministerial cooperation are discussed in Sections 17–19.

8. The Academy of Finland and the National Technology Agency Tekes, together with Sitra and other funding organisations, will develop their financing and other cooperation in order to improve the impact of R&D and innovation financing and to form and establish operational entities larger than the current ones. The funding organisations need to review the existing procedures and financing instruments and, where needed, develop new ones especially with a view to promoting interdisciplinary and inter-technological research and attracting foreign world-class experts to Finland.

9. A national strategy for creating and reinforcing internationally competitive science and technology clusters and centres of excellence will be devised under the direction of the Science and Technology Policy Council. The strategy will include proposals for developing extensive infrastructures and enhancing their utilisation.

Universities and polytechnics

10. The aim in the development of the university system is a system which is of high-standard in all its aspects and of a world-class standard in Finland's areas of strength and

whose internal capacity for renewal and reaction continuously generate new research openings and initiatives. The polytechnics will be developed as regional forces in accordance with the mission assigned to them and the practical needs of companies. The higher education system will not be expanded. The development measures will be targeted under the leadership of the Ministry of Education to ensure and promote the impact, quality, content and efficiency of the units by means of larger, focused resource entities, stronger networking and more effective management and performance evaluation.

11. Universities will improve their international competitiveness by sharpening their profiles and by investing in the quality of research, interdisciplinarity and research personnel of an internationally high standard. The organisations maintaining polytechnics, together with the Ministry of Education, will have to ensure that polytechnic units are of a sufficient size and comprise multiple fields and, together with the utilisers of R&D, to invest in high-standard education which responds to working life needs in the regions and in the development of applied R&D according to their missions. International education supply will be developed through an increase in foreign-language undergraduate and postgraduate education in Finland, a supply of degree programmes to be arranged in other countries and the improvement of services geared to foreigners. The possibility of charging tuition fees to non-EEA students will be explored with a view to budgetary decisions in autumn 2005. In Sections 10 and 11, the special characteristics of the Swedish-language university and higher education system will be taken into account.

12. University management, strategic planning and research administration will be stepped up and research will be assembled into larger entities with a view to more synergy and a larger number of critical masses and multidisciplinary research entities. The strategic management and administration of universities will be overhauled with emphasis on the growing demands due to changing university missions and operational environments. Training for research management will be increased.

13. The economic powers of universities will be enlarged by legislative means with a view to enhancing the prerequisites of national and international world-class knowledge and know-how and networking. Under the leadership of the Ministry of Education, the overall management of financing and finances in universities will be raised to a level required by their expanding responsibilities by means of a cost calculation reform designed to enable the real costs of all activities to be monitored and taken into account in financing transparently and on equal grounds. The possibility of raising the maximum tax relief for donations made by companies for research will be explored.

14. The formula for calculating direct budgetary funding for universities will be revised under the leadership of the Ministry of Education. In addition to strengthening basic operations, a larger share of the funding will be allocated on the basis of educational and research quality, with due regard to the special characteristics of different disciplines. Financing will also be allocated to structural reforms and the reform of the universities' own steering systems. Competitive financing will be increased in support of the renewal and specialisation of higher education institutions and with a view to enhancing the quality of research. The performance indicators will be revised under the leadership of the Ministry of Education as required by the objective.

15. The option of transferring immaterial rights from higher education institutions against shareholding to companies in which the institutions are shareholders will be enlarged and

made more flexible by legislative means. Higher education institutions must have up-to-date strategies for cooperation and for the transfer of technology and research results which take into consideration the opportunities offered by different intermediaries. In addition, universities must devise clear action models for university companies; the viability of the legislation taking effect on 1 August 2005 will be reviewed according to need.

16. The Ministry of Education, in cooperation with different partners, will revise the Development Plan for Education and University Research in view of this Resolution and submit it to the Government by the end of 2005.

Sectoral research and government research institutes

17. All the Ministries, in their respective fields, will assess the proposals put forward in reports published by the Prime Minister's Office, the Ministry of Education and the Ministry of Trade and Industry in autumn 2004 concerning sectoral research and its utilisation both in ministries and in research institutes and, based on the assessment and this Resolution, draw up timetabled development and utilisation programmes for sectoral research in their administrative fields. The programmes will be submitted to the Science and Technology Policy Council by 30 September 2005. The development programmes will be drawn up in collaboration with the other administrative sectors also affected by the proposals in the report.

18. After the completion of the development programmes for sectoral research, the Government will appoint a working party to devise an overall plan for targeting sectoral research and allocating its resources according to the changed needs in society.

19. All the ministries will appoint a person or unit responsible for directing and coordinating the strategic planning of sectoral research and the use of research resources in the administrative field and for developing mechanisms for the utilisation of research.

20. The ministries will increase their uncommitted research financing and develop financing and other cooperation with the Academy of Finland and the National Technology Agency Tekes. Each ministry will develop performance management in cooperation with the research institutes in its administrative sector with the aim of ensuring that the tasks of the institutes both in producing research results needed by the sector and in developing basic competence are realised and that the cooperation networks required for the activities are strengthened.

21. The research institutes will acquire more external research funding and increase its share in their R&D activities. The ministries and the research institutes will develop the management of their research funding and cost calculation and harmonise their billing principles in order to ensure that the real costs of the operations can be appropriately monitored and taken into consideration in financing.

22. The role of the Technical Research Centre of Finland (VTT) in the implementing of innovation policy will be strengthened. VTT will develop its competitiveness and basic competence especially in selected priority areas of major relevance to Finland and in accordance with the national strategy referred to in Section 9. The basic financing of selected fields in VTT must be strengthened.

Intermediaries

23. Measures will be taken under the leadership of the Ministry of Trade and Industry to develop strategy processes linking up regional- and local-level players and innovation environments with national innovation policy. Connected with this, measures will be taken to strengthen the status and prerequisites of the technology centres as part of the national innovation system.

24. The primary goal in developing the knowledge and technology transfer services is to improve private services and their prerequisites. The public services will be geared to eliminate market and system failures. Cooperation between funding organisations will be developed by means of common service models in order that the international and national processes and networks efficiently reach the local level.

25. The targeting of the Centre of Expertise Programme to top-level knowledge and its utilisation will be improved and the linkages of the Programme with innovation policy will be enhanced. Measures will be taken to clarify the division of work between the public organisations participating in the programme and boost cooperation between them. The next programme, to be launched on 1 January 2007, will be more clearly integrated into national innovation policy. To achieve these aims, the responsibilities of the Ministry of Trade and Industry will be enlarged in the new programme.

26. Within industrial policy, innovation policy measures targeted at the intermediaries will be directed to the long-term development of knowledge-intensity. The intermediaries will intensify cooperation amongst themselves and networking with public research organisations. The knowledge base of the intermediaries will be strengthened and training supporting this will be increased. The Ministry of Trade and Industry will step up the assessment of the impact of the intermediaries.

Monitoring and evaluation of the implementation of the Resolution

27. The Ministries will report to the Government on the development decisions required by this Resolution and the action taken. The first implementation reports must be submitted to the Science and Technology Policy Council by 30 June 2006. The Council will issue its opinion on the reports and put forward proposals for the further measures it considers necessary. The proposals will be harmonised with the work of the working party referred to in Section 18.

28. The Academy of Finland and Tekes will jointly carry out a review of the impact of the structural development measures of the public research system as part of the general development of impact analysis relating to R&D and innovation, which is one of the duties assigned to them.

APPENDIX 4

Government Decree on the Science and Technology Policy Council of Finland 847/2005

27 October 2005

1 §

Science and Technology Policy Council of Finland

For the handling of important matters concerning research, technology and their utilisation and evaluation there shall be a Science and Technology Policy Council of Finland.

2 §

The remit of the Council

The remit of the Council shall be to assist the Government and its ministries by:

1) following international developments in research and technology and the development needs they cause in Finnish research and technology
2) addressing major matters relating to science and technology policy and preparing plans and proposals concerning them for the Government;
3) addressing the overall development of scientific research and researcher training;
4) addressing the development and utilisation of technology and technology impact analysis;
5) addressing important matters relating to international science and technology cooperation;
6) addressing the development and allocation of public research and innovation funding;
7) addressing important legislative questions concerning research, technology and scientific education; and
8) taking initiatives and putting forward proposals in matters within its remit to the Government and its ministries.

3 §

Composition of the Council

The members of the Council shall be the Prime Minister as chair, the Minister of Education and Science and the Minister of Trade and Industry as vice-chairs, the Minister of Finance and up to four other ministers appointed by the Government. In the appointment, care shall be taken to ensure that the administrative sectors of major relevance to research are represented on the Council.

In addition to the ministerial members, the Council shall comprise ten other members well versed in matters within the purview of the Council. The Council shall include the representation of the Academy of Finland, the Finnish Funding Agency for Technology and Innovation, the universities, business and industry, and employees. The Government shall appoint the non-ministerial members for a term corresponding to the parliamentary term. Their term of office shall continue until the new members have been appointed.

If a Council member resigns or becomes incapable of executing his or her duties during the term of office, the Ministry of Education, after having heard the Ministry of Trade and Industry, shall appoint a new member in his or her place for the remainder of the term.

4 §

Subcommittees

The Council shall have a science policy subcommittee and a technology policy subcommittee. The Council may delegate power of decision in matters expressly specified by it to a subcommittee.

The science policy subcommittee shall be chaired by the Minister of Education and Science and the technology policy subcommittee by the Minister of Trade and Industry. The Ministry of Education shall appoint one member to the science policy subcommittee and the Ministry of Trade and Industry one member to the technology policy subcommittee. Each of these members shall serve as vice-chair of their subcommittees. The Council shall appoint the other members of the subcommittees from amongst themselves.

The Council may also set up other subcommittees from amongst its members to prepare matters.

The Council and its subcommittees may consult permanent and ad hoc experts.

5 §

Operation of the Council

The Council and its subcommittees shall meet at the invitation of the chairman or, if he or she is indisposed, at the invitation of a vice-chair.

The Council is quorate when the chair or one of the vice chairmen and at least six other Council members are present. A subcommittee is quorate when, including the chair or the vice-chair, at least half the members of the subcommittee are present. Matters shall be decided by simple majority. If the votes are equal, the chairman shall have the casting vote.

6 §

Secretariat

For the preparation of matters, the Council shall have a secretariat comprising a full-time secretary general and at least two full-time chief planning officers within the scope of the State Budget.

The secretary general shall lead the work of the secretariat. The secretary general shall be appointed by the Government after having heard the Council. The chief planning officer acting as secretary to the science policy subcommittee shall be appointed by the Ministry of Education and the chief planning officer acting as secretary to the technology policy subcommittee by the Ministry of Trade and Industry after having heard the Council. The secretary general and the chief planning officers shall be appointed for a maximum term of four years at a time.

The qualification requirement for the secretary general shall be a Master's degree, proficiency required for the post and proven leadership skills.

The qualification requirement for a chief planning officer shall be a Master's degree and proficiency required for the post.

The Council's clerical work shall be performed at the Ministry of Education.

7 §

Fees

The amount of remuneration to be paid to the chair, members, experts and secretaries for attendance at meetings shall be determined by the Ministry of Education. Compensation for the cost of travel shall be subject to the terms of the state collective agreement.

8 §

Entry into force

This Decree comes into force on 1 January 2006.

This Decree repeals the Decree of 12 December 1986 on the Science and Technology Policy Council of Finland (934/1986), with subsequent amendments. The Science and Technology Policy Council appointed under the Decree to be repealed shall function as the Council referred to in this Decree and its term shall continue until the new members have been appointed after the National Election held after the entry into force of this Decree.

At the entry into force of this Decree, the secretariat of the Science and Technology Policy Council of Finland shall carry on as the secretariat referred to in this Decree.

Measures needed to implement this Decree may be taken before the Decree comes into force.

Helsinki 27th October 2005

Minister of Education
Antti Kalliomäki

Counsellor for Higher Education
Juhani Hakkarainen

APPENDIX 5

SCIENCE AND TECHNOLOGY POLICY COUNCIL OF FINLAND

Chair:
Prime Minister Matti Vanhanen

Deputy Chairs:
Minister of Education and Science Antti Kalliomäki
Minister of Trade and Industry Mauri Pekkarinen

Minister Members:
Minister of Finance Eero Heinäluoma
Minister of the Environment Jan-Erik Enestam
Minister of Labour Tarja Filatov
Minister of Culture Tanja Karpela

Members appointed by the Government:
Development Manager Eija Hietanen, The Central Organization of Finnish Trade Unions SAK
President and COO Olli-Pekka Kallasvuo, Nokia Corporation
Director General Erkki Leppävuori, Technical Research Centre of Finland VTT
Academy Professor Risto Nieminen, Helsinki University of Technology
Professor Taina Pihlajaniemi, University of Oulu
Director General Veli-Pekka Saarnivaara, Finnish Funding Agency for Technology and Innovation
CEO & President Juha-Matti Savola, Juvantia Pharma Ltd
Rector Krista Varantola, University of Tampere
Professor Terttu Vartiainen, National Public Health Institute and University of Kuopio
President Raimo Väyrynen, Academy of Finland

Permanent Experts:
State Secretary Risto Volanen, Prime Minister's Office
Permanent Secretary Markku Linna, Ministry of Education
Permanent Secretary Erkki Virtanen, Ministry of Trade and Industry
Director General Sakari Karjalainen, Ministry of Education
Director General Paula Nybergh, Ministry of Trade and Industry

Secretariat:
Secretary General Esko-Olavi Seppälä
Chief Planning Officer Kai Husso
Chief Planning Officer Marja Pulkkinen

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