Research and Developemnt in Estonia
2000–2001

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By Marek Tiits and Rein Kaarli

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More detailed analysis and action plans will be added to the review in CD-ROM version.

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Knowledgebased Estonia

Executive Summary

The Regular Report published by the European Commission on 13 November 2001 on Estonia's progress in preparation for accession to the European Union did not consider the Estonian economy to be ready for accession yet[1]. Indeed, to-date Estonia does have a functioning market economy, but fails to meet the other relevant precondition for accession defined at the European Council's Copenhagen Summit in 1993 – at present it has no competitive edge against the rivalry from the technologically more advanced states on the European Union's internal market with its incomparably more intensive competition.

At the European Council's Lisbon Summit in March 2000[2], a strategic goal was jointly defined for the year 2010, according to which the European Union is to become the most innovative and competitive area in the world, whose innovation-based economy would be characterised by a growth in the intensity of R&D activities forming up to 3% of its GDP. Thus, in order to ensure Estonia's socio-economic cohesion with the European Union, its R&D and innovation policy has an important role to play in the country that is aspiring to EU membership and whose total R&D expenditure today accounts for only 0.7% of its GDP (1999).

During its ten years of independence, Estonia has created a stable monetary system and macroeconomic environment; whereas its privatisation and opening of markets have attracted foreign investments. This has enabled to modernise the infrastructure by implementing new, more intensive and economical production methods. By now Estonia has become an investment-based economy that successfully implements technology[3]. But ensuring sustainable economic growth requires an environment that would promote generation of new knowledge and (technological) solutions based thereon.

According to the Global Competitiveness Report 2001, Estonia ranked 27th among the countries of the world by its indicators of economic competitiveness. While pointing out the stable economic environment as a strength, the report also revealed as a weakness that the country's present R&D level will not be able to warrant long-term competitiveness.

As a surprise, the above Report placed Finland first in the rank before the USA, Canada and Singapore, its success being explained as follows: "…this country's remarkable turn to success in the past decade serves as a clear evidence of how fast strong political institutions, a focus on technology, and sound macroeconomic management can change a nation's prospects." Finland's success can primarily be put down to its strength in the areas particularly affecting a country's innovation potential – education, R&D activities, and application of information technology. Among the key reasons for Finland's (and also Ireland's) success, political consensus and a broad understanding of the drivers of sustainable economy were pointed out.

In keeping with the R&D strategy adopted by *Riigikogu* (the Estonian Parliament) on 6 December 2001 Estonia should focus on three key areas of high technology which are of paramount importance both for the development of new high-tech industries and for the renewal and modernisation of the existing traditional enterprises. To build up a critical mass and attain the essential standards of international competitiveness, national programmes will be worked out for of the selected domains.

Orientation to the local strengths is in every way favoured by the EU initiative to create a common research and development area which calls for international cooperation in solving major research and technological problems. The government's initiative to preferentially develop selected Estonian centres of excellence and to establish applied technology centres with a view to facilitating the liaison between universities and companies has an all-round favourable effect on Estonia's

1 Regular Report 2001, http://europa.eu.int/comm/enlargemnent/index.htm

2 Lisbon Summit, Innovation in a knowledge-driven economy, http://europa.eu.int/comm/enterprise/

3 Global Competitiveness Programme, World Economic Forum, http://www.weforum.org

integration into international strategic partnership.

The innovation policy survey carried out in six candidate countries on the initiative of the European Commission[4] refers to the rigidity of the Estonian system of education – despite the high formal level of education, the supply of education fails to conform to the changed needs of the quickly developing society – Estonia is simultaneously experiencing both a lack of qualified labour and unemployment. The conclusions of the survey suggest that more attention should be paid, at various levels of education, to developing creativity and entrepreneurship, as well as to raising corporate awareness about innovation and implementation of relevant innovation management techniques.

In the past few years, both the patterns of organising Estonian R&D activities and the corporate support structures have undergone a series of organisational changes. Despite that, the cooperation between universities, enterprises and innovation support structures is weak and requires substantial strengthening. Likewise would the efficiency of different public sector support measures for research and innovation need to be raised by way of better focusing. Therefore, the future research and innovation policy must be based on analysis and to a larger degree aimed at longer-term goals.

In summary, it is important that Estonia's current direction, which aims to support R&D activities and innovation, should not be discontinued and that the ensuing developments would be clearly predictable. The signals sent by planned state financing for setting priorities are important for strategic planning of both research institutions, companies, as well as foreign investors.

It is equally important, too, that in Estonia the coordination of the various national policies affecting R&D and innovation should be improved, and the planned growth in public investment supporting the national R&D strategies would actually take effect (similarly to the other Candidate Countries).

4 Innovation Policy in Six Candidate Countries: The Challenges, Sept 2001.

Introduction

The present Annual Report of Research & Development in Estonia aims to familiarise the reader with the Estonian R&D Strategy 2001–2006 "Knowledgebased Estonia", passed by Riigikogu, the Estonian Parliament, on 6 December 2001, against the background of the country's cultural and economic environment.

The first report of the newly formed Research and Development Council on the R&D activities in Estonia briefly reviews:

- the development of R&D and innovation policy in the world;
- the current state of Estonian R&D activities and the trends that have led to it;
- the latest changes in the Estonian research and innovation system;
- the indicators characterising the Estonian R&D activities in the last few years.

The chief target group of the publication comprises public policy makers and financers of R&D activities, giving them an opportunity to estimate the situation and the role of R&D in ensuring Estonia's future competitiveness in economy, culture, and other sectors of society.

The authors trust that the report will likewise spark the interest of researchers, entrepreneurs and innovation support structures, as well as of everyone else fascinated by the role of research and innovation both in Estonia and in today's rapidly changing world.

R&D activities at revolutionary times

Immediately after the invasion of France by the German troops, Vannevar Bush, head of the Carnegie Institute at the time, suggested to Franklin D. Roosevelt, President of the United States of America, that he could set up a council that would assist in applying the country's scientific potential to the inevitable intervention in the armed conflict in Europe[5].

The proposal was accepted and a system was soon launched to act as an intermediary for universities and industrial research, while also supplying federal financial support to projects pursuing specific goals. Such a model proved to be extremely efficient in managing the designated application of the competence available in academic, federal and industrial structures. Several technological solutions were created which later proved crucial to the course of the war: a radar was created at the Massachusetts Institute of Technology, a rare fissile isotope of uranium ($^{235}U_{92}$) was first separated in the laboratory of the General Electric Company. The University of California administered the top-secret Los Alamos laboratory, whose research & development activities subsequently led to the creation of the nuclear bomb.

Already before the end of the war President Roosevelt turned to Bush, who had become his de facto research advisor, asking for advice about application of research and technology for the purposes of economic development and social welfare in peacetime conditions. The thorough report received from Bush several months later emphasised the importance of federally coordinated research programmes in ensuring national welfare. Its opening sentences stated that "without scientific research no amount of achievement in other directions can guarantee our health, prosperity, and security as a nation in the modern world"[6].

Techno-globalism. Its links with the national R&D and innovation policy

The breakthrough that took place half a century ago in the attitude of the USA, known for its liberal *laissez faire* economic policy, characterises the formation of modern research and innovation policy in the majority of developed industrial countries. Strengthening of cooperation between applied research and strategic industries was seen a few decades later, during the cold war, as the basis for economic competitiveness and a key to the success that would ruin the rival. An understanding of the importance of joint activities engaged the entire US research and economy in the name of a noble cause – to be the first to send a human to the Moon[7].

The rapid development of commodities markets and the trend towards industrial production that began in the 1970s have gained further momentum thanks to the free movement of capital established at the end of the same decade. Today, social scientists regard the exploitation abroad of technologies generated in the home country as the most rapidly growing form of globalisation[8].

The developed world sees scientific development as the primary means of improving the general wellbeing of people – both in the economic and social spheres. R&D activities are regarded as the engine of technological development and hence of increasing productivity. However, research as a source of new skills is not the only important aspect. It is equally important to ensure close substantive cooperation between the application mechanisms related to economy, research and industry, the two "worlds" positioned somewhat apart from each other in today's Estonia[9].

5 U.S. National Science Foundation, Science and Engineering Indicators 2000.

6 Bush, V. 1945 Science – The Endless Frontier: A Report to the President on a Program for Postwar Scientific Research, http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm

7 Speech by President Kennedy in 1962, http://science.nasa.gov/headlines/y2001/ast30may_1.htm

8 B-A. Lundvall, S. Borrás, The Globalising Learning Economy: Implications for Innovation Policy, http://www.cordis.lu/tser/src/globec.htm

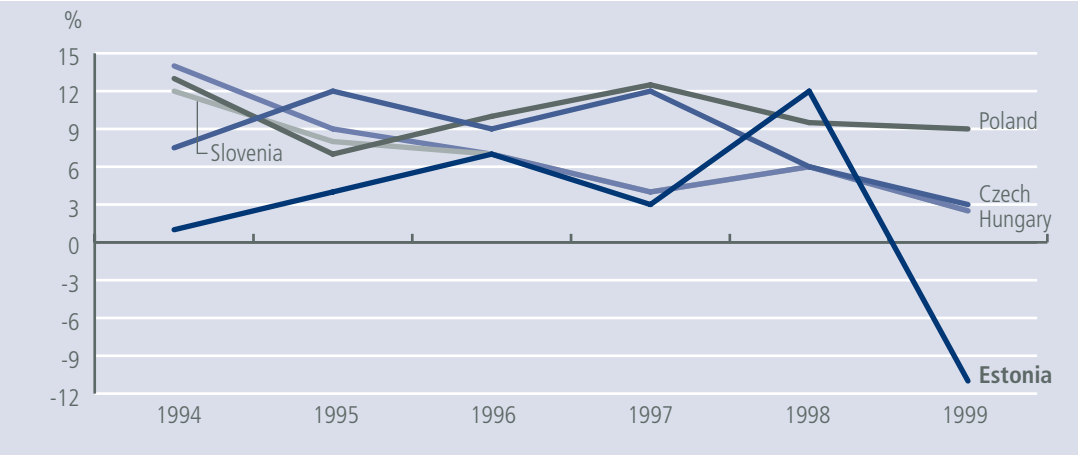
9 H. Hernesniemi, Evaluation of Estonian Innovation System, 2000.

Even though the links between the country's economic, research and technology policies have been strengthening during the last decades, they are far from being simple or direct. Consequently, nor can a comprehensive public policy be narrowly shaped on the basis of short-term economic development alone, which is why, instead of separate research and technology policies, the world speaks more and more of innovation policy, involving both of them as well as various other fields, as a means of enhancing the competitiveness of a state or region. Such innovation policy focuses on elements of research, technology and industrial policy that *"explicitly aim at promoting the development, spread and efficient use of new products, services and processes in markets or inside private and public research organisations"*[10].

No less important in shaping the innovation capacity of both people and a state is a sound educational policy, since at the core of an emerging knowledge-based learning society is its people's ability to put behind their outdated grasp of matters and acquire new knowledge as rapidly as possible.

During its ten years of independence, Estonia has created a stable monetary system and macroeconomic environment; its privatisation and opening of markets have attracted foreign investments. Alongside with closing down inefficient production, this has enabled the country to modernise its infrastructure by employing more intensive and sustainable production methods. Together with other EU candidates, Estonia has developed into a successful investment-based economy.

Figure 1 – **Changes in labour force's productivity in manufacturing** (percentage)[11]



At the same time, the competitive ability of an economy does not depend so much on the industries in which it specialises but rather on *how* successfully particular enterprises can develop in their areas of specialisation and compete at the global level[12]. The presence of sufficiently qualified human resources, financial capital, and high-quality infrastructure is paramount. Equally important is the existence of both a competitive market forcing companies to constantly improve the quality of the offered solutions, and top-level domestic demand.

An economy which depends on a steady inflow of foreign investment while specialising in relatively low-value-added subcontracting operations is very vulnerable to external financial shocks. The desire to harmonize Estonia's living standard with the European average places a challenge on the whole society to transfer to an innovation-based economic model by way of

10 B-A. Lundvall, S. Borrás, The Globalising Learning Economy: Implications for Innovation Policy.

11 EBRD Transition reports 1999, 2000.

12 M. Porter, The Competitive Advantage of Nations.

remarkably increasing the *per capita* added value produced in Estonia and switching over from an importer of technology to a creator of new solutions.

At the same time, scientific research creating new knowledge is global; therefore it is worthwhile to investigate only those areas in which earlier results are not available. On the other hand, the process of innovation as the implementation of previously unapplied novel ideas in particular contexts appears to have a distinctively local character. Realising this, the majority of large-scale corporations have renounced establishing their production bases, as well as research and development centres for developing new solutions "in an empty place" abroad. Instead, they attempt to access the already existing, usually narrowly specialised, bases for "knowledge production" both at home and abroad.

It is in the local, closely intertwined innovation networks of organisations that human capital is developed in cooperation between education, research and enterprise, and improved products and services are jointly created. In view of such a model, the innovation system is referred to as *elements and relationships that are either inherent in or originate from the country, which exert an influence on the creation, distribution and utilisation of new and economically useful knowledge*[13].

Thus the quality of life in a country as a whole depends on the ability of particular economic entities to make use of such knowledge infrastructure in order to achieve possibly higher productivity to be gradually increased over time[14]. The public sector can ensure such developments by "forcing" enterprises to constantly improve their competitive advantages, while removing obstacles from their path to economic development and boosting the factors that facilitate innovation.

In the long term, the rivalry between countries and regions boils down to competition in their ability to ensure a possibly more favourable environment for the generation of new knowledge and innovation. An enterprise or a country that fails to create an innovation-fostering environment will in due course end with being trapped in its existing technology, which in its turn will lead to its growing lag from the more developed and innovative, since innovation breeds more innovation in favourable conditions. The inability to invest in the generation and application of new knowledge will in time trap an enterprise or a country in the lane of slow development, from which it is very difficult to gain new momentum[15].

To sum up, all the aforesaid clearly refers to the increased role of a national research and innovation policy, supporting both the generation of the relevant knowledge and skills necessary for the creation and application of new technologies as well as the purposeful involvement of state, private and foreign investments in the development of more competitive products and services.

13 B. Lundvall, National Systems of Innovation, 1992.

14 The productivity of the Estonian labour force in 1998 was 37% of the European Union's average, and slightly less than the candidate states' average. Eurostat 2001.

15 P. Sheenan, New Frameworks for Innovation and Growth: Theory and Policy, 1999.

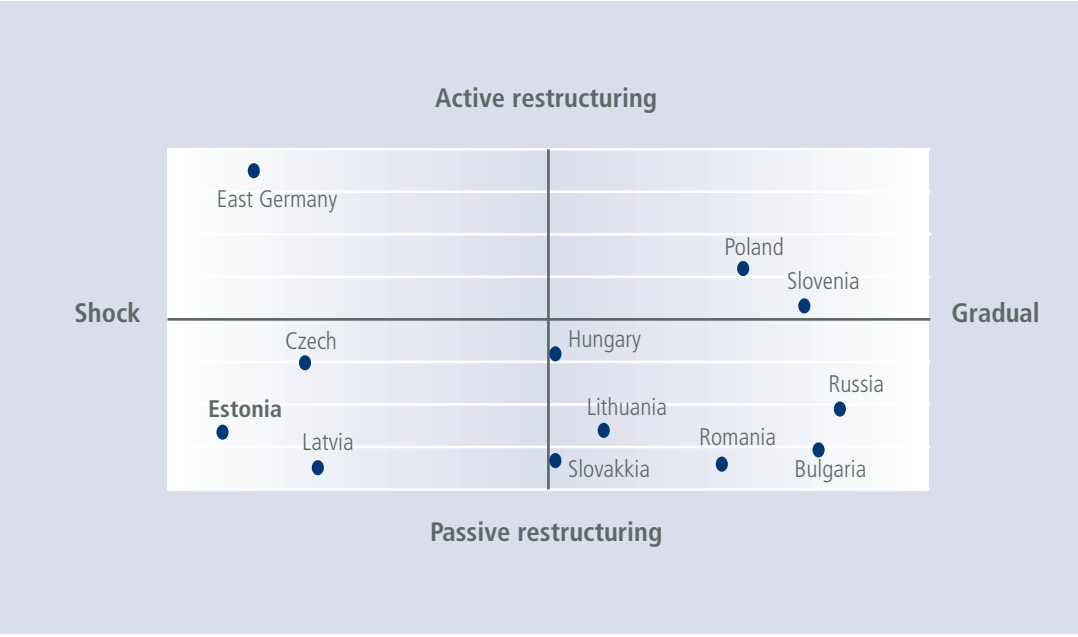
Estonian R&D and Innovation Policy

The need for policy reviewing

When Estonia regained its independence in 1991, its scientific research found itself in a situation where many earlier users of R&D services and the sources of state financing were lost. The newly independent country's government lacked funds for adequate financing of research, but the share of the private sector in funding R&D activities was only 10%. Thus it was decided to reorganise the Academy of Sciences, the largest scientific research organisation so far, taking into account both the results of an international evaluation and the research institutes' own suggestions[16].

Several (subsidiary) institutes that had earlier engaged in applied research to service the Soviet Union's military and industrial sector were closed down. Such radical changes made it possible to strengthen higher education and raise the level of basic research in universities, but the relative share of industry-orientated applied R&D work fell drastically. The latter sector was practically eliminated, giving ground to consider this one of the most draconian changes in Central and Eastern Europe[17].

Figure 2 – **Reconstruction of industrial R&D activities in Central and Eastern Europe**



The economic growth witnessed by the countries of Central and Eastern Europe in the last decade was largely achieved thanks to the fact that the new opportunities accompanying the opening of the frontiers and the markets were seized, inefficient branches were closed down and foreign investment related technological modernisation took place. However, this "brief", foreign-trade-relations- based integration into the European economic system and the introduction of new technology contributed by foreign investments need not have a long-term positive effect on increasing the added value produced in Estonia. The actual "thorough" integration into international economy depends on whether the Estonian economy can integrate foreign investments, whether the foreign investments induced technological influx will remain related to the need of single

16 A. Köörna, Iseseisva teaduspoliitika sünnitusvalud (Labour Pains of an Independent Research Policy).

17 S. Radosevic, Restructuring and reintegration of Science and Technology Systems in Economies in Transition, 1996.

enterprises to raise productivity or can be extended to a broader development environment via local suppliers and partners, thus consistently increasing the added value produced in Estonia[18].

The national R&D and innovation policy has thus by far not lost its cutting edge under the conditions of growing globalisation and intensifying international technological cooperation[19]. The environment provided by the government for innovation activities plays a key role in attracting knowledge and technology intensive foreign investments and maintaining hi-tech, highly productive enterprise. Realising and accepting this, the choice of political priorities aimed at the reproduction of adequately qualified human resources, and ensuring the existence of a well-functioning institutional infrastructure will become increasingly important[20].

Both long-term economic scenarios and labour productivity trends indicate that how successfully the candidate states can blend into the enlarging European Union depends on their ability to maintain economic growth rates, while switching from an investment-based economic model to one based on technological innovation. At the same time, the poor innovation management capacity of Estonian enterprises and the limited demand for R&D have started to decelerate technological innovation based economic development[21]. In many cases, enterprises operating in nominally hi-tech sectors have specialised in segments that either have low added value or are difficult to export (i.e. sub-contracting, assembly, services).

Thus, in order to safeguard well-balanced development in the process of transfer to the knowledge and innovation-based economic model, it is important to work out a substantive base document that would lay down the widely accepted and regularly updated strategies for the development of national R&D and innovation.

The Estonian R&D strategy 2002 – 2006 "Knowledge-based Estonia", which was passed by *Riigikogu* on 6 December 2001, responds to those challenges, stating:

"The Estonian research and development strategy sees future Estonia as a knowledge-based society, in which research aimed at seeking new knowledge, application of knowledge and skills, and development of human capital is a source for economic growth, improved competitiveness of labour force, and quality of life. In a knowledge-based society, scientific research and development activities are valued as a precondition for the functioning and development of the whole society".

The key for substantive implementation of the above strategy will consist in ensuring a possibly more effective functioning of the national innovation system, supported in the main areas by a stable policy maintained across several terms in office of the government and parliament. Alongside with strengthening the analytical basis necessary for policy making, the relationship with national development planning is acquiring a greater role. The latter in turn provides the basis for cooperation in pursuit of common goals of research and enterprise, and the support schemes of such cooperation.

18 S. Radosevic, D. Dyker, Technological Integration and Global Marginalisation of Central and Eastern European Economies: the Role of FDI and Alliances, 1996.

19 Ireland has become a somewhat warning example of this possibility, where foreign investments have improved the living standard, but the support of the local innovation system has proved insufficient to maintain the attained level. The government has a serious problem maintaining foreign capital based efficient production.

20 Globalisation of Industrial R&D: Policy issues, OECD 1999.

21 Innovation Policy in Six Candidate Countries: The Challenges, Sept 2001.

EU Impacts

No European country can support R&D activities with equal dedication to all possible areas. Neither can a small country like Estonia do it. Therefore it is all the more important to identify the areas of specialisation that would support cultural, economic and social development best of all, while maintaining a critical mass in the other areas of R&D to meet the local needs and keep up with the developments in the world at large.

In January 2000, Philippe Busquin introduced to the public the European Commission's initiative for shaping a common European Research Area[22] as part of the "Lisbon Strategy"[23]. The goal of the initiative is to unify the organisation of research in the European Union and its 15 member states by drafting a common European R&D and innovation policy, coordinating national initiatives more intensively and thereby improving the efficiency of the investments made into research, which are too small in comparison with the rest of the world.

The European Union stresses its role particularly in strengthening European cooperation, involving, if need be, top competence in specific areas from elsewhere in the world. At the same time, the role of the public sector at the national and regional levels is primarily seen in consolidating the basis of local scientific and technological competence and in supporting specialisation in the local strengths.

The process started in Estonia with the aim of selecting the national centres of scientific excellence partly responded to that challenge, assigning 4 million EEK as supplementary finance to six scientific centres in the year 2001. However, the five times greater total financial support to two Estonian centres of excellence from the 5th Framework Programme in 2000[24], as well as the potential contributions from a similar competition round which is presently under way[25] have undoubtedly played and will continue to play an incomparably greater role in the strengthening of Estonia's best R&D centres and facilitating their process of joining the international research community.

As a matter of fact, it is critically important for Estonia to be able to cooperate internationally in the field of R&D, and belong to the networks connected with the generation, application and distribution of new knowledge. This is so because of its limited human and financial capital, its poor capacity for establishing global standards, and its limited capability to produce and market competitive products on the world market. All these circumstances call for involvement of foreign strategic partners in the R&D activities carried out in Estonia.

Indeed, partly prompted by the European Commission's initiative to establish a common European Research Area and by several international R&D programmes, Estonia has started to revise the priorities of its national R&D and innovation policy and to strengthen its resource base through international cooperation.

It was in 1994, under the EU 4th Framework Programme of R&D activities (1994–1999) which expanded to Central and Eastern Europe to a limited degree, that Estonia first entered international R&D cooperation as a free market competitor. Five years later it became associated with the 5th Framework Programme (1999–2002), which put almost all its R&D activities in an essentially new perspective. Suddenly, although in tough competition with European research centres and large-scale enterprises, financial resources that were dozens of times larger than those that Estonia was used to[26] became available for R&D projects. Due to this and a number of other reasons,

22 European Research Area, http://www.cordis.lu/rtd2002/

23 COM (2001) 79 final, *Realising the European Union's potential: Consolidating and extending the Lisbon Strategy.* Contribution of the European Commission to the Spring European Council, Stockholm 23-24th March 2001.

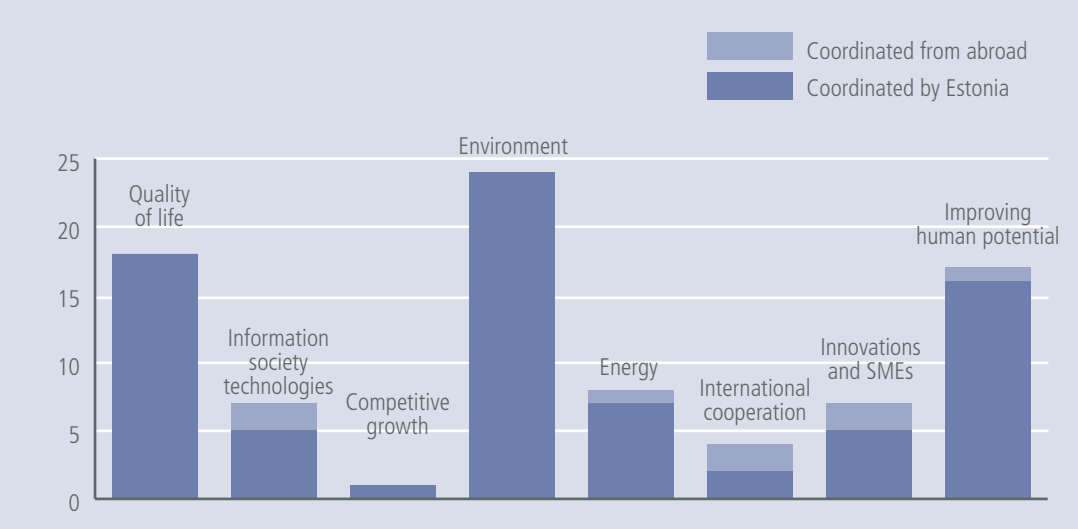
24 Institute of Physics of the University of Tartu, Estonian Biocentre.

25 Dedicated additional measures to further improve participation of Newly Associated States in FP5, http://www.cordis.lu/inco2/calls/notice_nas.htm, Innovaatika 7(49) Sept 2001, pp.2-3.

26 The average financing provided under the EU 5th Framework Programme to an R&D project is approximately 25 million EEK. Usually the participants in the project also make their own contributions.

this particular instrument has become the international cooperation programme that has affected Estonian R&D activities most noticeably during the last years.

Figure 3 – **Estonia's participation in EU 5th R&D Framework Programme** (number of projects)[27]



The capacity to participate in international projects offers an excellent learning opportunity in the field of strategic planning of R&D, innovation management, etc. At the same time, a clear distinguishing line is emerging between those who are better able to compete in international R&D programmes and those who are not.

In their attempts to participate in European R&D programmes, Estonia as well as the other Central and Eastern European countries have faced a number of problems. A survey carried out within the framework of the *Ideal-ist* project brings out the following points as the main obstacles:[28]

- many potential participants in R&D projects fail to see the logic behind competitive programmes aimed at solving specific socio-economic problems; on the other hand, it is extremely difficult to plan a successful project if one has a limited understanding of the rules;
- due to the weakness of the liaison network, finding suitable strategic partners for successful launching of projects is often a major problem;
- having little experience and only limited knowledge of the world market, it is extremely complicated to plan application schemes and business strategies for projects whose scale is much broader than one is accustomed to.

As the main instrument of initiating the European Research Area, the European Union sees its 6th Framework Programme (2002–2006), which is presently being planned. In connection with the latter, once again drastic changes are under discussion with respect to the modality of projects and a remarkable increase in their financial capacity. When speaking of the need for integrated projects with budgets amounting to hundreds of millions kroons, the hitherto average project volumes are regarded as insufficient for solutions of adequate market capacity.

On the one hand, it is therefore paramount to participate in projects focusing on issues that are strategically important for Estonia. At the same time, one has to keep in mind that EU programmes

27 Participation of Estonia in the 5th Framework Programme, January 1999 – January 2001.

28 J. Kadlec, Determination of the problems of participation in IST for the NAS.

account for only 5% of the European public sector investments in R&D; the projects financed from cooperation programmes are aimed at solving the socio-economic problems of Europe as a whole, and not all of them need to correspond to Estonia's interests. The considerably more extensive financial possibilities of European R&D programmes in comparison with what Estonia is used to, will exert remarkable pressure on the choice of the targets and subjects of national R&D activities, which need not always coincide with Estonia's strategic interests. It is up to the government to balance these factors, while ensuring long-term sustainable development of the national innovation system.

Changes in the organisation of R&D activities in Estonia

The legal grounds for organising Estonian R&D activities were laid down by the Organisation of Research and Development Act[29], which regulates the role of different governmental agencies as well as the methods of management and coordination of the whole system. According to this Act, the country's R&D policy is carried out by the Ministry of Education, while its innovation policy is the responsibility of the Ministry of Economic Affairs.

To work out a comprehensive R&D and innovation policy and ensure its efficient functioning, it is necessary that the interests of research, economy or any other area should not prevail so as to dictate how the remaining parts of the innovation system must function. Research and industrial policies must therefore be coordinated both mutually and with educational, environmental, regional, social and other policies.

Unfortunately, until now neither the measures for working out and regular updating of the R&D and innovation policies, nor the various implementation structures supporting new initiatives have been as strong as required. As a consequence, researchers, entrepreneurs and the public have no clarity about the interrelationships between the goals, financing and outcomes of R&D.

Consequently, a mere project-based approach to either the financing of R&D activities in their entirety or any single instruments therein is insufficient. Nor is it sufficient if separate components subordinated to different ministries work well. Organising R&D activities is part of long-term planning, which presupposes as background knowledge a much broader comprehension of future Estonia as it is envisioned by politicians, scientists and entrepreneurs. In planning an overall research and innovation strategy, it is relevant to build stronger connections between various national development plans, not losing sight of the capabilities of Estonian research and industry in finding solutions to the tasks they face.

The research & development strategy "**Knowledge-based Estonia**" reflects a recognition of the increasingly greater role of research and innovation in shaping Estonia's future. The strategy aims to ensure reproduction of knowledge and skills, renewal of the traditional industries, and their integration into the rapidly developing, knowledge-intensive areas of new economy. The key technological areas for achieving these goals are information society technologies, biomedicine and materials technologies. Thanks to implementation of the strategy, the intensity of Estonian R&D activities is expected to have significantly improved by the year 2006. The long-term goal is to bring development closer to that of the Nordic countries, which means that the total expenditure on R&D should grow and reach 1.5% of the GDP by the year 2006 (0.76% in 1999). Implementation of the strategy focuses on strengthening the basis of knowledge and skills, improving the innovation capacity of enterprises, promoting internationalisation, and facilitating liaison between industry and research.

Also, an amendment to the Organisation of Research and Development Act entered into force on 10 April 2001, making a number of specifications to solving the discrepancies that emerged in the process of enforcement of the Act. Amongst other matters, ministries ' competencies in organising R&D were specified and the basic regulations concerning the size and membership of the R&D Council advising the Estonian Government in R&D strategy issues were modified.

The activities of the newly formed Research and Development Council are based on two standing committees, one focusing on R&D, the other on innovation policy. At the head of the committees are, respectively, the Minister of Education and the Minister of Economic Affairs.

29 Organisation of Research and Development Act http://seadus.ibs.ee/aktid/rk.s.19970326.122.*.html

In order to meet its targets, the R&D Council approves an annually updatable three-year plan of activities, which involves among others:

- ensuring of the analytical basis necessary for planning and assessing the R&D activities and innovation strategy for the forthcoming periods, including analytical reviews, evaluation of the applied measures, technology foresight, comparative policy research, etc.;
- issues concerning coordination and linking of measures related to or affecting the national R&D programmes, other R&D activities and innovation, or the policies subordinated to different ministries, taking into consideration the corresponding international initiatives and the needs and possibilities to participate therein;
- planning of the resources necessary for attaining the R&D and innovation policy goals, including the availability of sufficient human and financial resources.

As part of the reorganisation of the R&D Council, its secretarial office was also reorganised, strengthening its role and daily activities in creating the analytical basis necessary for developing Estonia's research and innovation policy.

Conducive to the above is the initiative taken by the Ministry of Education in 2000 to establish the Estonian R&D information system[30]. As a result of natural development, information about R&D projects, their contents and outcomes has so far been maintained diffusely by different entities in Estonia, which is why getting a comprehensive picture of the area has been somewhat complicated. The system that is being established will support getting a much better analytical insight, provide a clear understanding of the area distribution of R&D activities, financing and results, and will undoubtedly facilitate both the formation and evaluation of the Estonian R&D and innovation policy.

The system will likewise give the institutions and scientists involved in R&D a new opportunity to promote their activities in Estonia and internationally, helping to apply the results of research work in practice.

30 Estonian research and development activities information system, Archimedes Foundation.

Structure and tasks of the Estonian R&D and innovation system

The key elements of the Estonian research system are the universities as the principal centres for generating new knowledge, followed by minor institutes and R&D establishments. These are the main institutions to which public sector investments in this area are directed.

The core of the national innovation system also includes, besides those mentioned above, enterprises participating in R&D activities, and different state structures responsible for R&D and innovation policy. These are naturally complemented by other companies, political parties and other organisations that have a direct or indirect effect on scientific development.

The progress of new knowledge and solutions from research to economy and society cannot be viewed as a linear process in which enterprises take over "ready-made" research results that have already been published in international journals. In modern economy, close cooperation between researchers and enterprises is required at all stages of R&D projects, starting with defining the tasks of basic research and ending with implementation of a prototype in production.

However, the international evaluation carried out in 2000 revealed various problems in the functioning of the Estonian national innovation system as a whole. The needs of the society and the actual R&D activities do not accord with each other to the degree required. The changes characteristic of a transition society have, quite understandably, forced both the public and private sector to focus on the most urgent problems. The structure of the R&D and innovation policy instruments combined with the youth and smallness of enterprises has thus implied for Estonia, compared to developed countries, a relatively small share of the business sector in R&D investments.

Herein the primary role of the state is to bring the different parties of the innovation system in due time to the common goals and initiatives. One way to do so is to establish in universities technology centres specialising in applied R&D. It is since the end of the 1980s that, based on local and regional initiatives, a number of attempts have been made in Estonia to set up science parks and innovation centres which copy the "western models". Unfortunately, due to lack of coordination, limited skills and financial resources, and inadequate specialisation within the national innovation system as a whole, most of them have shown only sluggish performance.

In this context, the public sector's interest during the last years in the establishment and strengthening of technology and innovation centres is highly appropriate. Experience shows that technology and innovation centres should, in order to raise the effectiveness of their activities, concentrate on some single narrow area(s) in which their existing competence basis would provide future possibilities to participate in the international technology market as creators of new solutions[32].

No small state can be successful in all areas and solve all its problems at once. That is why it is reasonable to specialise in the key areas as specified by the Estonian R&D strategy: information society technologies, biomedicine, and materials and nanotechnologies.

31 H. Hernesniemi, Evaluation of Estonian Innovation System, 2000.

32 Technology centres - activities and effects, Ministry of Trade and Industry of Finland together with Finnish Science Park Association TEKEL & Otaniemi Science Park.

Foresight and designing of public R&D programmes

Considering the future areas of specialisation, one has to admit that the dominant world view in Estonia's relatively young society is confined to short-term local and regional development:[33]

- there are no internationally important large-scale enterprises or subsidiaries of international concerns engaged in product development;
- the existing innovation and product development are mainly orientated to the domestic market, the industry lacks sufficient competence and resources to compete with the global leaders in the area;
- the resources provided for R&D by both the public and private sector are extremely limited.

In order to maintain the pace of development gained during the last decade and increase the competitive ability of research and economy, it is important to support the development of strategic thinking in both the private and public sector by forging a common understanding about Estonia's future prospects and thus help shape concordant public policies.

Monitoring the future as a social process involving many participants is not without significance in raising the efficiency of the innovation system by centralising the available information on the future and drafting long-term development visions. As a skilfully carried out process that looks ten or more years ahead:[34]

- it will break down communication barriers and will help strengthen informal cooperation networks, since rivals will be able to find more ways for joint action even in everyday activities when they analyse more distant perspectives;
- it will help formulate visions of long-term development and interpret the conclusions following therefrom for today's decisions.

Within the framework of one such foresight[35], the European Joint Research Centre is identifying the effects of the planned enlargement of the European Union, at the same time pointing out potential threats, research needs and opportunities for technological development.

When conducted effectively, foresight will identify the likely needs and opportunities to specialise in certain areas of research, thus giving public policy makers, entrepreneurs and scientists important input for drafting R&D programmes necessary for their area of responsibility.

That is why the analysis of the innovation system, which was carried out in 2001[36] in the field of information-based society technologies, will continue. It has provided a number of ideas for shaping the policies in the next year by means of foresight of information society technologies underlying the plans in the field.

33 J.P. Gavigan, F. Scapolo, Reconciling foresight with policy making at regional level, JRC/FOREN 2001.

34 A Practical Guide to Regional Foresight, FOREN 2001.

35 Enlargement Futures, Joint Research Centre, http://www.jrc.es/projects/enlargement/

36 Evaluation results of information society technologies are already available at http://www.esis.ee/eVikings/

Indicators

Scientific research, post-graduate training and provision of higher education are traditionally seen as the primary realms of universities. However, in addition, today's universities are increasingly expected to commit themselves to meeting various expectations and needs of society, to cooperate more and more extensively with other R&D institutions and users of research outcomes.[37]

However, the results and effects of research are frequently intertwined, which makes their impact on social development difficult to measure. It is hard to overestimate the positive effects on the labour market and the competitiveness of economy that accompany the training of new researchers and the growth of tacit knowledge. It is equally difficult to express such impacts in figures. In no country is collecting such material part of official statistics. Yet, without such background information, it is impossible to make well-grounded judgements about the R&D and innovation policy. The shaping of a sustainable development strategy requires more and more special research that would describe the effectiveness, mutual cooperation and potential problems of various components of the innovation system, as well as the effects of the legislation and different policies on these components.

For next year, the Research and Development Council is planning a substantial addition to the single research projects carried out in Estonia so far. As a relatively thorough review of the situation of R&D activities was made only last year[38], this review will confine itself to presenting only the most important indicators characterising the situation in R&D.

Financing of R&D activities

The existence of national competitive financing is one of the prerequisites for the development and quality of the national innovation system. When launched in a targeted manner, this is also the main means of directing R&D activities and innovation processes, one of the most important guarantees to the efficiency of cooperation between different parties. Any additional funding allocated by the public sector should be therefore regarded as a public policy instrument, which supports the establishment of a scientific competence basis in the desired direction, contributes to the formation of cooperation networks between universities and enterprises, etc.

Between 1995–1998, the investments into the R&D activities in Estonia remained at the level of 0.6% of the GDP , and increased to 0.76% in 1999[39], thus being about 40% of the respective European Union average (1.85% of the GDP). Although R&D investments in current prices have doubled in Estonia since 1995, the real growth has been modest. The average annual growth in investments has been 4.5% on average in terms of the 1995 stable prices.

In the majority of candidate countries with transitional economies, the bulk of investments in R&D are public sector investments. The share of business sector financing exceeds that of the public sector only in Slovenia, the Czech Republic and Slovakia. In Estonia, 64% of the investments made into R&D in 1999 came from the public sector, 24% from the business sector and 9% from abroad. At the same time in the European Union, enterprises financed 55% of R&D activities, the share of the public sector being 36%.

37 The State and Quality of Scientific Research in Finland - A Review of Scientific Research and its Environment in late 1990s.

38 R.Kaarli, T.Laasberg, Research and Development in Estonia 1996-1999: Structure and Trends. Research and Development Council, Tallinn 2000.

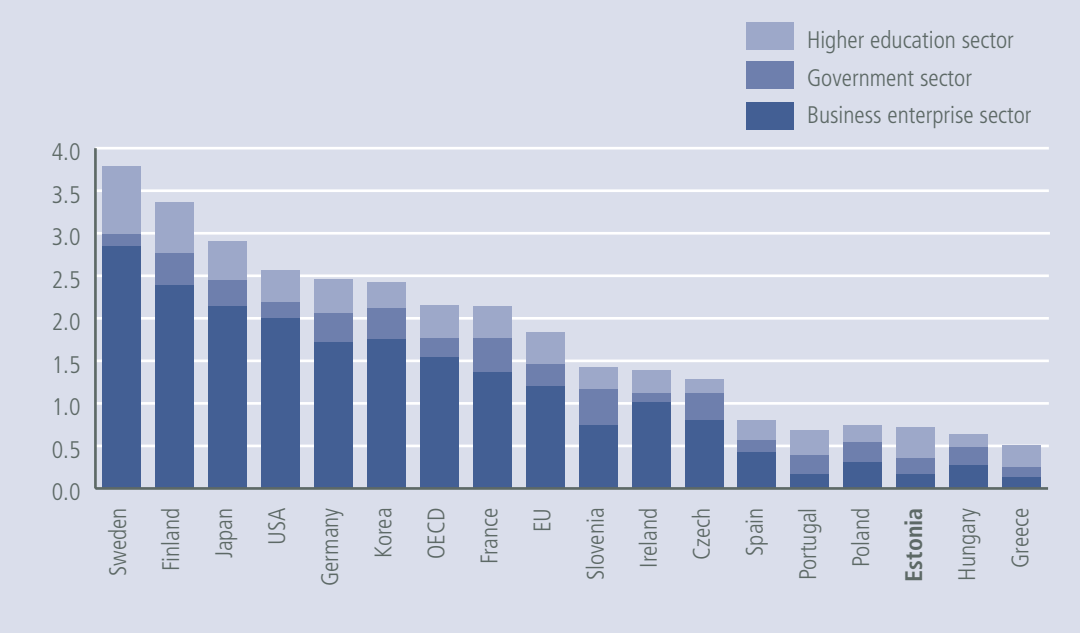
39 Estonian Statistical Office, 2001.

R&D expenditures by sectors of economy

In the course of the Estonian structural reform of the 1990s, a vast majority of the research institutes of the Academy of Sciences merged with universities. Accordingly, over half of the R&D resources available in the country also concentrated into the universities. While in 1995, 28.2% of the total R&D expenditure was incurred by universities and 71.8% by the public sector's research activities, in 1999 the R&D activities performed by universities already accounted for 50.9%, the share of public sector institutes having fallen to 24.7%.

Both in Estonia and the industrially less developed EU member states (e.g. Greece, Portugal), R&D is mostly carried out by the government and the higher education sector, the share of the business sector being only 20–30%. On the other hand, in the European Union on average, the business enterprise sector performs 65% of R&D, while the respective share in the OECD countries is 70%, in Sweden and the USA even 75%.

Figure 4 – **Participation in R&D activities in 1999** (% of GDP)[40]



Data on the business sector's R&D activities have been collected in Estonia since 1998. According to the Statistical Office, in 1999 the business sector accounted for slightly less than 25% of all the R&D activities. In the same year, every 29th enterprise with 20 or more employees was involved in R&D in Estonia (in 1998, only every 39th)[41]. According to official statistics, in 1999, intramural expenditure on R&D activities in the business enterprise sector grew nearly 1.5-fold, compared to 1998. The volume of R&D contract-work ordered from abroad decreased from ca 150 million EEK to 13 million EEK[42].

40 Main Science and Technology Indicators, 2001/1, OECD; Statistical Yearbook "Science", Estonian Statistical Office; data about Finland and Germany are for the year 2000, those on Greece and Ireland for 1997.

41 Estonian Statistics 2/2001.

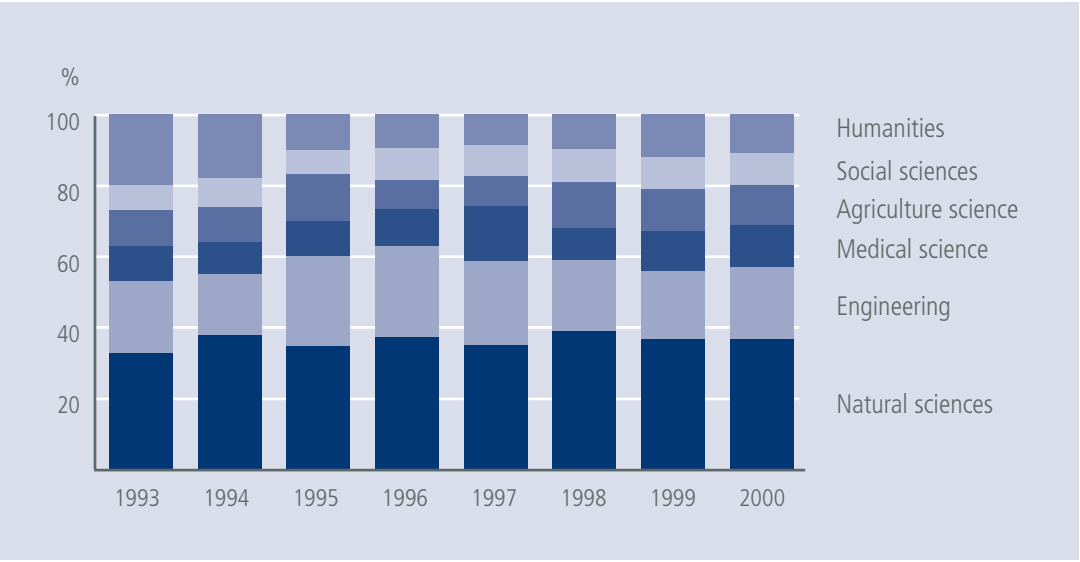
42 The basis for international R&D statistics is the R&D activities carried out domestically, which is why investments in foreign countries are excluded from traditional statistics, nor are they reflected in the Estonian data on financing R&D.

Table 1 – **Gross Domestic Expenditure on R&D (GERD) 1995 and 1999**[43]

Year	Gross Domestic Expenditure on R&D (GERD)		Government Intramural Expenditure on R&D (GOVERD)		Higher Education Expenditure on R&D (HERD)		Bussiness Enterprise Expenditure on R&D (BERD)		
	Million EEK	% GDP	Million EEK	% of total expenditure	Million EEK	% of total expenditure	Million EEK	% of total expenditure	% GDP
1995	250.6	**0.60**	179.9	71.8	70.7	28.2			
1998	450.9	**0.61**	107.4	23.9	252.7	56.0	88.8	19.3	0.12
1999	572.8	**0.76**	141.6	24.7	291.7	50.9	137.0	23.9	0.18
2000	579.4	**0.68**	140.0	24.2	303.7	52.4	130.4	22.5	0.15

The extremely large structural variances in the data, as well as the innovation system analysis carried out in the information technology sector give reason to suspect that the recently commenced collection of official statistics might not provide an all-round picture of the R&D situation in the enterprise sector. A number of enterprises probably erroneously include under R&D also routine product development, which does not involve scientific research and thus does not actually belong to it according to the substance and the internationally applicable definition of R&D[44].

Figure 5 – **R&D expenditure of universities and research institutions by fields of research**



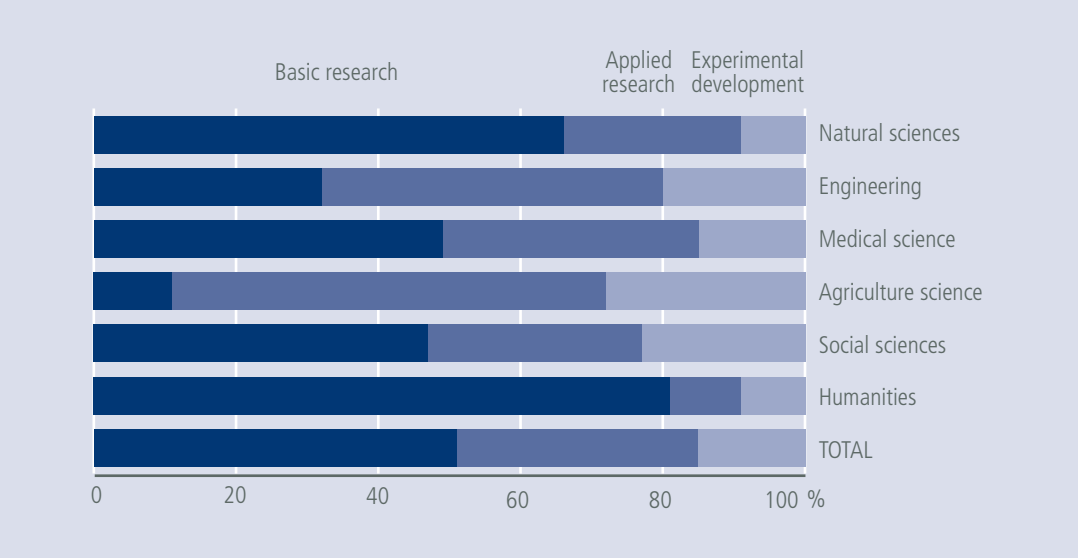
Over the years, the division of expenditure by the subjects of R&D activities[45] has changed little in the government and higher education sector. The main source of financing in all the fields of research are the public sector funds, which cover more than 80% of the total expenditure. Engineering and agricultural sciences get the largest shares of the business enterprise sector funds (28% and 14%, respectively), other fields receiving only 2–3%.

43 Data on the business enterprise sector's R&D activities have been collected in Estonia since 1998.

44 Proposed standard practice for surveys of research and experimental development - Frascati Manual, OECD 1993.

45 Estonian Statistical Office.

Figure 6 – **Types of R&D activities by field of research in 1999**



The types of R&D activities vary greatly within the fields of research[46]. In 1999, applied research accounted for 91% of overall R&D in agricultural sciences (development 43%) and 74% in engineering (development 23%). Natural sciences, on the other hand, were much more orientated to basic research.

46 Estonian Statistical Office.

Human resources

One of the main indicators of the human capital involved in knowledge-based economy is the relative share of researchers involved in R&D activities in the total labour force[47]. According to the definition provided by the Frascati Manual, researchers involved in R&D activities are holders of a scientific degree or a university diploma; they are involved in basic and applied research and are engaged in experimental and development work as professionals. This does not include the academic staff of universities, heads of research institutions and their departments, who are not directly involved in R&D, or persons who are employed as engineers but do not hold a diploma, performers of routine analyses, bibliographers, programmers, etc.

As many researchers are, due to the specificity of their activities, besides their other work (academic posts in universities, etc.) involved in R&D on a part-time basis, the international statistics use full-time equivalent to assess the human resource involved in R&D activities, the basis of which is the actual working time dedicated to research and development.

In Estonia, there were 4.3 researchers per 1,000 employees in 1999 in the total of all the economic sectors as expressed via full-time equivalent. This is somewhat less than the EU (5.3) and OECD average (6.1). With respect to this indicator, Estonia is at the same level with Slovenia, but exceeds the majority of other candidate and cohesion countries.

Table 2 – **Number of researchers and engineers per 1,000 employees in Estonia and in some OECD countries**[48] 1995/1999

Estonia	4.3/4.3	Ireland	4.0/5.1	Japan	10.1/9.9
Slovenia	/4.1	Spain	3.0/3.7	Finland	6.7/9.9
Slovakia	3.9/3.6	Italy	3.3/3.3	Sweden	7.7/9.1
Poland	2.9/3.3	Portugal	2.4/2.7	Iceland	7.2/9.3
Hungary	2.6/3.1	Greece	2.0/2.6	USA	7.4/8.1
Czech Republic	2.3/2.6			France	6.0/6.1
				United Kingdom	5.1/5.5

Compared to the 1995 level, the number of researchers expressed in full-time equivalent has steadily grown in the European Union, for instance, by approximately 16% per annum in Ireland and by 12% per annum in Finland.[49] At the same time, in candidate countries with transitional economies the number of researchers has been quickly decreasing since the beginning of the 1990s. In fact, Hungary and Poland have managed to reverse this trend in the recent years.[50]

In Estonia, the number of researchers expressed in full-time equivalent dropped from 3,813 in 1993 to 3,109 in 1995. Considering also the business sector data, the number of researchers in full-time equivalent has practically remained at the same level since 1995. The proportional number of researchers per 1,000 employees has likewise remained stable at 4.2–4.3 from 1995 to 1999.

However, between 1997 and 2000 the number of researchers in engineering dropped by 45%. Yet, the total number of researchers and engineers having remained the same, it is possible that part of them have switched to the business sector, where the number of researchers rose by *ca* 180 persons in 1998–1999.

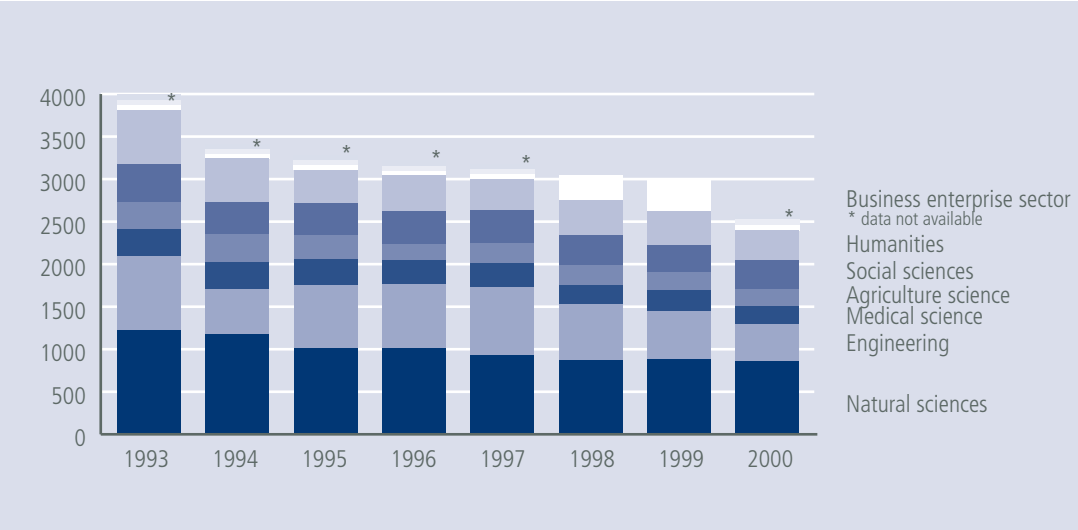
47 According to the Frascati Manual, the number of employees is the economically active part of the population, including unemployed persons.

48 Eurostat, Statistics in Focus, Research and Development, Theme 9 - 3/2000, R&D expenditure and personnel in candidate countries and the Russian Federation in 1998; OECD, Main Science and Technology Indicators, 2001/1; data: 1999 or the closest year.

49 Towards European Research Area - Key figures 2001 - Special Edition: Indicators for benchmarking of national research policies, European Commission, Luxembourg 2001.

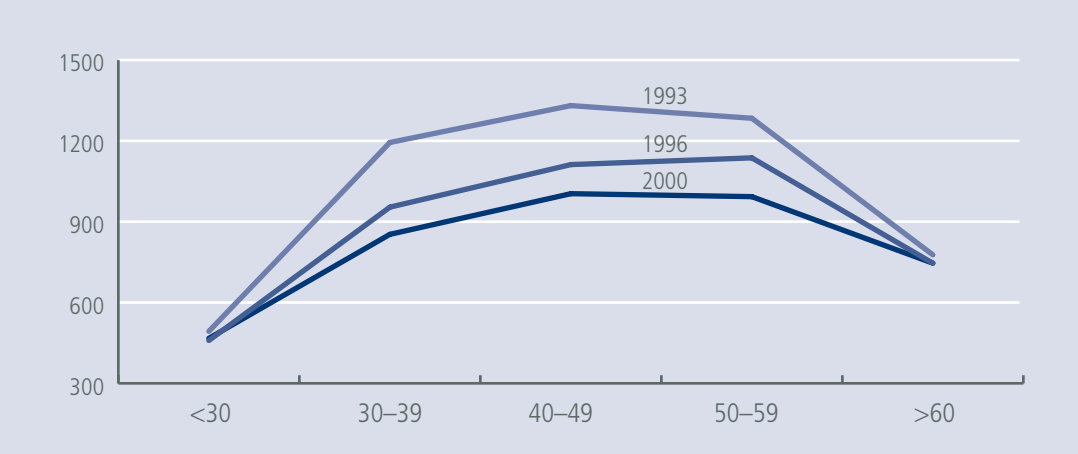
50 Main Science and Technology Indicators, 2001/1, OECD, 2001.

Figure 7 – **Number of Estonian researchers in full-time equivalent by fields of research**[51]



The age distribution dynamics of researchers shows that the tendency within the academic community towards rapid aging that prevailed during the first half of the 1990s has now come to a halt. Since 1995 the average age of researchers and engineers has been 46–47 years.

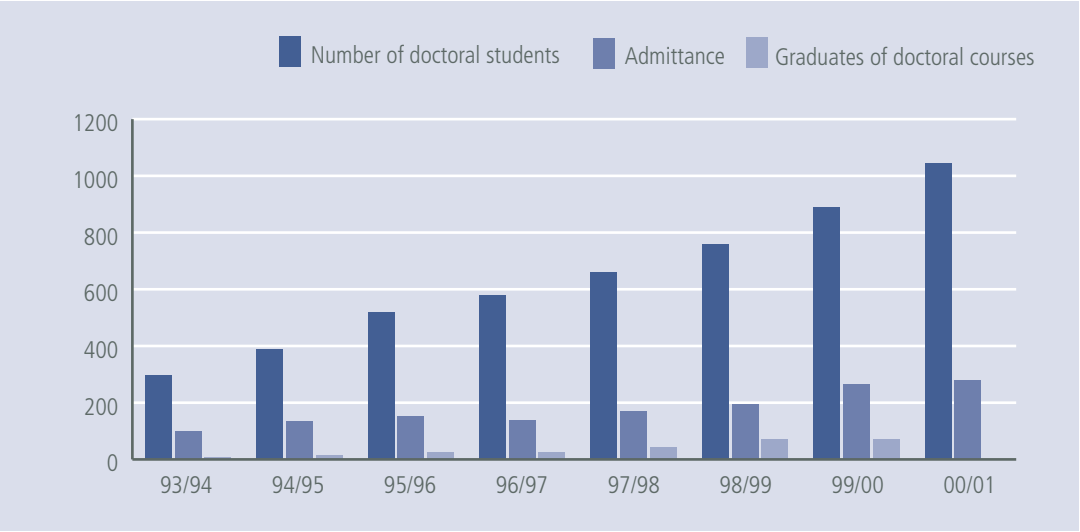
Figure 8 – **Age structure of researchers**



Reproduction of the human resources necessary for R&D is best characterised by the efficiency of graduate studies. Of all the persons enrolled in doctoral studies in 1992, only 27 (15%) completed their studies in four years' time. In the year 2000, however, 72 (50%) of the persons who had been enrolled in doctoral studies four years earlier concluded their studies; 40% of them did so in the area of natural sciences and two-thirds at the University of Tartu.

51 Source: Statistical Office; business sector data are not available for 1993–1997 and 2000.

Figure 9 - **Doctoral studies in 1993–2000**



Estonia needs ca 80 new doctors per annum to ensure the continuity of education and research. Following the example of the developed countries, we would need another 80 to work outside the public sector's research institutions. If, however, we wanted to copy the Finnish and Swedish respective proportions, taking into account the needs of knowledge-intensive enterprise[52], the country would need even 200 new doctoral degree holders per annum.

52 Materials of the Research and Development Council sessions of 1.3.1999 and 31.5.1999 .

Publications

Among the main indicators characterising the effectiveness of R&D activities are certainly data about the publication and citation of scientific articles, and about the amount of filed patent applications.

To assess the effectiveness of research and follow the publication of results, the following international databases are used:

- Science Citation Index (SCI) database, containing entries on articles from 3,300 leading scientific journals in 100 subject areas,
- Social Science Citation Index (SSCI) database, comprising similar data from 1,400 journals (plus selected information from 7,000 journals) in 50 subject areas of social sciences; and
- Art and Humanities Citation Index (AHCI) database, containing data on articles from 1,100 journals (plus selected data from 7,000 journals) in 25 subject areas of humanities.

Like with other indicators, no far-reaching conclusions can be drawn merely on the basis of the number of publications entered in the international Citation Index or the amount of registered patents. For example, in many areas of engineering a large number of (business sector) R&D results never get published or patented as (non)publication and protection of the results may be part of the business strategy. It is often more important to bring the solutions to the market as fast as possible, concealing the technical details.

A recent innovation policy survey[53] reveals that in comparison to high-income countries, R&D activities in candidate states are orientated to publication rather than patenting. In developed countries the situation is quite the contrary. The survey also discloses that, on average, residents of candidate states file three times as many patent applications per every euro spent on R&D than do cohesion states, and 1.4 times more than is done by developed countries. The scientists of candidate countries publish twice as many articles per every euro spent on R&D than do their counterparts in cohesion states and over three times more than do scientists in developed countries.

The number of articles published by Estonian scientists in journals belonging to the Citation Index database has constantly increased over the years. While in 1996 the number of Citation Index publications was 439 for the whole of Estonia, then in the year 2000 this number was already 635. The largest number of publications has come from the University of Tartu, the Institute of Physics of the University of Tartu, the National Institute of Chemical Physics and Biophysics, and Tallinn Technical University.

Table 3 – **Scientific publications by Estonian authors in the Citation Index databases**

Year	1995	1996	1997	1998	1999	2000
Articles	382	439	512	585	623	635

More than 50% of Citation Index publications from Estonia have been produced in collaboration with foreign authors, including those from the leading Western laboratories. The main cooperation partners are Sweden, Finland, Germany, the USA, Russia, France and Great Britain. In total, between 1996 and 1999 articles were published collaboratively with scientists from 38 countries.[54]

Regarding the number of international publications per capita, according to the Citation Index database, Estonia is lagging behind the majority of developed countries, but is on a par with the Central European countries.[55]

53 Innovation Policy in Six Candidate Countries: the Challenges.

54 Ülle Must and Grant Lewinson, Estonian International Co-operation in Science in the 1990s: New Politics, New Methods. 8th International Conference on Scientometrics and Informetrics Proceedings. Sydney, 16-20 July 2001. Bibliometrics & Informetrics research Group, UNSW, Sydney, 2001, Vol. 1, pp. 385-393.

55 R. Kaarli, T. Laasberg, Research and Development in Estonia 1996–1999: Structure and Trends. Research and Development Council, Tallinn 2000.

Patents

Estonian residents use very little patenting to protect their R&D results. The number of patent applications filed by residents per 10,000 inhabitants has been 0.1 since 1994, while the EU member states' average is 2.5. In order to achieve a similar level, Estonian inhabitants should file approximately 350 patent applications yearly.

Table 4 – **Number of patent applications in Estonia**[56]

	1994	1995	1996	1997	1998	1999	2000
Patent applications	482	82	213	375	463	619	805
including Estonian residents	16	16	12	15	20	13	12
Patents granted			22	108	82	103	84

While the amount of applications filed by Estonian residents has not changed over the recent years, the number of patent applications filed in Estonia by residents of other countries has redoubled.

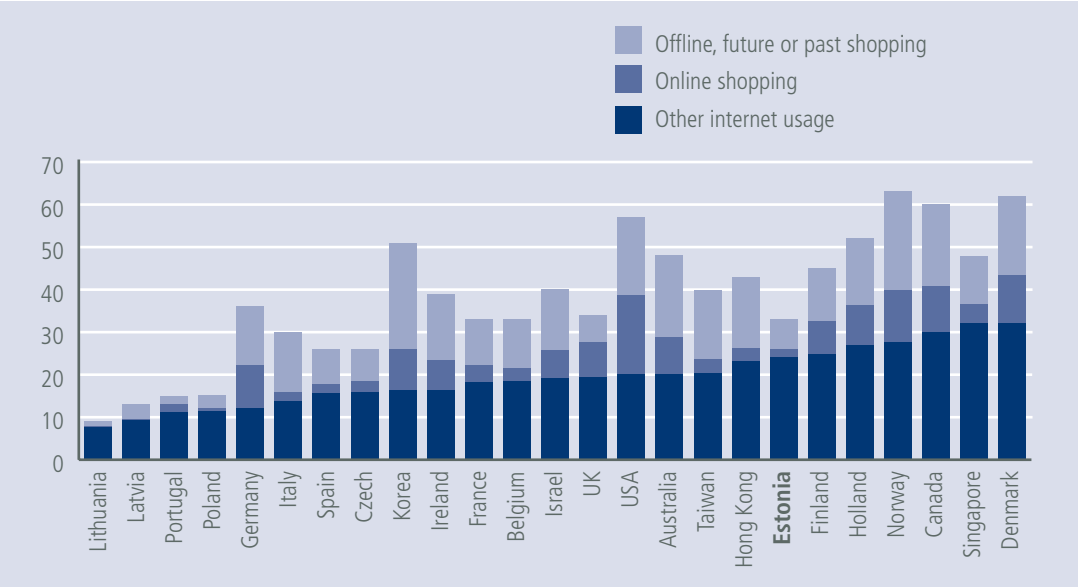
The modest patenting activity can be attributed to the small number of inventions having an application potential, which in its turn is caused by the orientation of the system to basic research and the orientation of enterprises to the narrow domestic market, in which the competitive ability rests on lower costs rather than unique production pursuing higher prices and larger profit margins. At the same time, foreign patenting involves specific imported goods and protection in Estonia of the unique production technologies that mostly accompany foreign investments.

56 Statistical Office, 2001.

Development of information society

Information society, which we are all conscious of, is the best illustration of the fact that the development of research and technology has a much broader impact on society, environment and the quality of life than the mere economic effect of technology transactions. Realizing this, the European[57] initiative "An Information Society for All" was launched in December 1999 as part of the Lisbon strategy, which strives to provide Internet access to everyone, to ensure digital literacy and such formation of information society that would strengthen social cohesion.

Figure 10 – **Percentage of Internet users among 15-75-year-old inhabitants**[58]



In the last ten years the number of Internet users has grown fairly rapidly in Estonia owing to an early take-up of new technology,[59] but since the year 2000 a certain stabilisation has taken place. In the 3rd quarter of 2001, 36% of 15–74 year-old inhabitants used e-mail or other network services.[60] At the same time, more than half of the adult population already use the Internet in Sweden (68%), Denmark (62%), Finland (54%) and Canada (53%). The OECD regards the cost of access as the chief factor determining the level of take-up of information technology and e-business solutions.[61] Considering its relatively lower living standard, it is natural for Estonia to lag behind the leaders.

However, it would be a great mistake to regard technology as "a free gift" that comes about spontaneously; rather, today's technology developers are creating the rules for tomorrow's world. In 1997, expenses of enterprises on information technology R&D in Finland (51%), Ireland (47%), Canada (44%), Japan (40%) and the United States of America (38%) formed more than one-third of the total private sector investments in R&D.[62] In Estonia, the greatest investors in information technology implementation are the public sector and enterprises of the financial and telecommunications sectors. At the same time, the share of R&D product development is not big.

57 eEurope Action Plan, http://europa.eu.int/information_society/eeurope/action_plan/index_en.htm
58 Global eCommerce Report 2001, Taylor Nelson Sofres Interactive.
59 Estonian Survey of Information Society, http://www.esis.ee
60 Emor press release, 23.10.2001.
61 Science, Technology and Industry Scoreboard. Towards a Knowledge-Based Economy, OECD 2001.
62 Finnish Statistical Office; Measuring ICT sector, OECD.

Afterword

On 6 December 2001 the Estonian Parliament *Riigikogu* passed the research and development strategy "Knowledge-Based Estonia" for 2001 – 2006. Estonia had thus joined the vanguard of the EU candidates that prioritise developing knowledge-based society. Being able to set a good example to one's neighbouring countries encourages and stimulates.

However, we have to realise that ascribing more importance to knowledge and innovation is a process that today is characteristic of the whole world, inevitably causing an ever growing gap between the socio-economically more advanced and less advanced countries. Knowledge has become one of the determining factors for advanced countries' economic growth; hence high-quality infrastructure of innovation is basic for a country's competitive ability.

Consequently, it is likely that the actual implementation of the R&D strategy may actually prove to be more challenging than any of us can estimate today. We will need to create an environment which would favour a maximum utilisation of the existing knowledge base, that is, we need to create a cooperation network in which clients, enterprises, support services, financial institutions and research institutes of the public sector would work hand in hand creating more added value.

Creation of knowledge-based society presupposes well coordinated society-wide activity which is focused on removing obstacles from the road of economic development and taking maximum advantage of the emerging new opportunities. The public sector must therefore coordinate the political, legislative and economic factors of all its areas of activity, and concentrate on enhancing the competitive ability of the country's more crucially important economic sectors, creating well-functioning systems of continuing education, re-qualification programmes and social guarantees.

Marek Tiits

Research and Development Council
Director of the Secretariat

13 May 2002