Table of Contents

Appendices

"Intellectual backwardness sooner or later leads to dependence…
knowledge alone is the only true might in the world."
István Széchenyi (1825)

PREFACE

The present century will even be more the century of knowledge, science and technology than the one we have just left behind. Leading Hungarian thinkers in past centuries realized the power of knowledge and science in shaping society and the future, and their importance in the life and advancement of the nation. The nation's great men and those prominent in Hungarian intellectual life always placed their talents and their outlook on the world at the service of the nation.

"A nation can be strong only if it conducts its own independent research. Therefore it is of crucial importance that it has a science policy...". Following on from these thoughts of Kunó Klebelsberg (Minister of Religious and Educational Affairs in the 1920s) and recognizing the outstanding importance of research and development, the Hungarian Government established the Science and Technology Policy Council (STPC) and its Science Advisory Board (SAB) in 1999. The main task of the SAB is to serve as an advisory, co-ordinatory, and evaluative body in the formulation of the Government's science and technology policy. A Government Resolution empowered the Science Advisory Board to work out the principles for Hungarian science and technology policy, to make an assessment of the country's research activities, and to define thematic priorities for research. As part of this work the members of the SAB and invited experts prepared studies in the wake of directives laid down by the Secretariat of the STPC. These studies served as the basis for a discussion document. The independent studies and the discussion document resulted in the first version of *Science and Technology Policy 2000.* The Science Advisory Board held two discussions on this working document, and accepted some modifications. Based on the document accepted, Government Resolution No. 1073/2000 (VIII. 31.) approved the launch of the National Research and Development Programs.

I should like to take this opportunity to express my gratitude to all those who by means of their devoted work have given great impetus to the preparation and publication of the document. Through their involvement they have contributed powerfully to the successful formulation of the National Research and Development Programs that serve the intellectual and economic advancement of the country, as well as to the fact that these have become parts of the Széchenyi Plan, which outlines a wide-ranging plan for Hungary's development. I owe special thanks to Dr. Dénes Dudits, István Fodor, Dr. Norbert Kroó, Dr. Rezső Lovas, Dr. Gábor Makara, Dr. Gábor Papanek, and Dr. Frigyes Solymosi.

Science and Technology Policy 2000 outlines a long-term development program for Hungarian science, technology and innovation. It is based on the conceptions and plans for the future of wide circles in Hungarian intellectual, economic and political life. This is the first time that such a program has been worked out and published in Hungary. The Government Program states

unequivocally that the state and the business community have a part to play in ensuring that research, development and production are brought closer to one another and placed in the service of the country's economic advancement. To achieve this, the country needs co-ordinated education, research, development, and innovation policies, as well as measures to stimulate the research and development activities of the private sector. The national programs formulated in this spirit include the main developmental directions, taking into account the economic, social and political changes taking place in the world as well as Hungary's national characteristics.

The forces of globalization (the development of a global market, a global economy and global finance) are producing two powerful effects in Europe: integration, which is basically a positive phenomenon, and homogenization, which is negative in its results. As one of a number of efforts to counteract this, a part of the national program aims to uncover and nurture our national heritage, as well as to strengthen our consciousness and ideals as Hungarians.

Hungary, a state founded by King Stephen the Saint, has been part of Europe for a thousand years now. During the ten centuries of our history *"We have remained Hungarians and by doing so we have given the most to Europe",* as Pál Teleki (a prime minister during the interwar years) once aptly put it. Hungary has always been in the mainstream of European development. Today, too, our National Research and Development Programs are in synergy with the development program of the European Union.

After centuries of struggles for freedom and wars of independence, and after the trials which followed the change of political and economic system in 1990, Hungary is today developing promisingly, and can deservedly be proud of the scientific findings of the country and of the intellectual power represented by its researchers. The development of the country can be measured in terms not only of material increase, but also of the achievements in science and the arts, and the gain in intellectual values.

Integrating Hungary into a united Europe represents for us the opportunity to preserve and increase Hungary's competitiveness. Integration also means that we can strengthen the security of Hungarians living beyond our borders and improve their economic position. It is our hope that in this way we can contribute to the promising process which – given political goodwill on all sides – could result in open borders for all the peoples of Europe. Hungary, which occupies a special position in the heart of Europe geographically and historically, has a good chance of becoming a bridge linking East and West, and of obtaining a leading role in European regional co-operation.

I am confident that the action program we are launching will accelerate the processes of economic catching up and social advancement in Hungary. The intellectual legacy of our great men and women and the future of our descendants oblige us to achieve this goal, which can be reached through great determination and broad national solidarity.

Dr. József Pálinkás
Chairman, Science Advisory Board of the STPC
Parliamentary Secretary of State, Ministry of Education,
Republic of Hungary

The key to Hungary's advancement is competitiveness. Creating social and economic conditions that foster competitiveness is crucial. *The economy of the 21st century will be based on knowledge.* The country can succeed in the globalizing world economy only if it is able to introduce new products and services of high quality and with significant added intellectual value. This is the only way we can accomplish our *basic objectives of*

- improving the quality of life of the citizens,
- achieving socially, economically and environmentally sustainable balanced development,
- ironing out differences in regional development,
- establishing competitive enterprises and creating secure, well-paid jobs.

Science and Technology Policy 2000 summarizes the science and technology policy actions necessary for achieving Hungary's overall objectives. The document gives an overview of the present situation under five headings: *human resources, institutional structure, financing, infrastructure, and international relations.* Based on these, the document sets out the goals and the actions necessary to achieve them.

Present situation

The section on human resources states – as its main findings – that the number of researchers employed in the Hungarian research and development sector is low; and that the increase in the average age of researchers and faculty members is alarming. The knowledge transfer between the research and business sectors is unsatisfactory. On the other hand, certain important research findings, the introduction of PhD training and the work of doctoral schools are encouraging.

The Hungarian R&D system consists of the following five main components: institutions of higher education; research institutes belonging to the Hungarian Academy of Sciences (HAS) and the Academy's research groups based at universities; R&D institutes belonging to government ministries; institutes of the Zoltán Bay Foundation for Applied Research; and the R&D facilities of companies. More than half of Hungary's R&D capacity is concentrated in Budapest. Research units vary significantly in the quality of the work they do. The capacity of the research institutes of ministries is relatively small. The links between university and Academy research laboratories and industry are weak. At many laboratories the infrastructure necessary for the given research has been developed; schools of science have evolved and international ties have been established.

The system of *financing* R&D is still bears the burdens of the past, and many of its elements need to be renewed. The salaries of researchers and faculty are on average low, vary considerably and are

insufficiently performance based. More than 60 per cent of total R&D expenditure comes from the state budget. Financial resources are thinly spread.

The most striking feature of the *infrastructure* is the dilapidated state of equipment. In many laboratories even its use and maintenance pose a problem. The informatics systems of specialist libraries differ from one another, and augmentation of stocks is increasingly difficult. The NIID Program eases the burdens by providing possibilities for high-speed information exchange.

Over the past decades a large number of *international* science and technology co-operation links have been developed. Hungary has become a full member in most pan-European research organizations and programs. Hungary participates in the European Union's RTD framework program as a full member. A number of Hungarian researchers work on mega-science projects at large research facilities abroad.

Goals and agenda

In the area of *human resources* the main goals are to strengthen public education, and to introduce and enforce the principles of quality and scientific values more strongly in research. It is also of prime importance to increase the number of PhD students and to bring PhD programs more in line with the needs of industry. To improve the supply of researchers and faculty, an *attractive career model* should be worked out. As part of it, postdoctoral programs should be established. The flow of knowledge and mobility between research institutes, higher education and industry should be promoted.

There is no need for a significant reorganization of the R&D *institutional structure.* Research institutes of national importance should be maintained by the state in the future, too. Academy research institutes, the universities and companies should be encouraged to engage in joint research. At small and medium-sized enterprises R&D research capabilities should be strengthened. The establishment and enlargement of R&D units at multinational and national companies should be supported. Regional differences in R&D capacities should be ironed out.

The system of dual-channel state *financing* of R&D based on institutional support and competitive project funding should be preserved. By the year 2002 total R&D expenditure should reach 1.5 per cent of GDP and the business sector's share of this should be at least 50 per cent. Budgetary support for research funds which allocate money on the basis of competition – among them the National Science Research Fund – has to be substantially *increased.* The profiles of research support funds should be clarified and their efficiency increased. In the fields of strategic importance *national research and development programs must be launched* utilizing competition-based funding.

To develop *infrastructure,* in line with the national research and development programs, a program for purchasing new scientific equipment should be launched. A library development program has to be started at higher education and research institutes to augment and digitalize library holdings and facilitate a concerted acquisition policy, as well as to secure faster and broader access to electronic databases.

Mainly those international co-operation programs should be developed which will enable us to learn and adopt methods of utilizing research findings commercially. As well as the support for the mobility of researchers, funds for worthwhile R&D work must be guaranteed. Hungary must strive to become a regional center for R&D in certain fields. Foreign researchers should be attracted to the country in as large a number as possible. To foster this the conditions for the establishment of Albert Szent-Györgyi Scholarships should be worked out.

National research and development programs

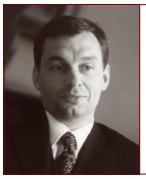
Concentrating resources and efforts is the only way to reach the critical mass necessary for the economic application of research results, for discovery of niches in the world market and for the establishment of regional research centers. In a resolution issued on August 31, 2000, the Hungarian Government approved the launch of the national research and development programs in the following five fields:

1. *Improving the quality of life,*
2. *Information and communications technologies,*
3. *Environmental and materials research,*
4. *Research on agribusiness and biotechnology,*
5. *Research on the national heritage and contemporary social challenges.*

The national research and development programs will be complemented by technology policy measures to promote links between research and business sectors and the utilization of R&D results.

THE STRUCTURE OF THE SCIENCE AND TECHNOLOGY POLICY COUNCIL AND THE SCIENCE ADVISORY BOARD

Since the Government considers research, development and innovation to be important, it established the Science and Technology Policy Council (STPC) to shape science and technology policy. At the same time an advisory, evaluative and co-ordinatory body, the Science Advisory Board (SAB), was set up to support the work of the Council. The SAB consists of two sections, one governmental and the other drawn from representatives of business and scientific life. The STPC and the SAB function on the basis of Government Resolution 1038/2000 (V.5.).



Viktor Orbán
Prime Minister

József Hámori
Member of HAS
Chairman of the STPC

Zoltán Pokorni
Minister of Education

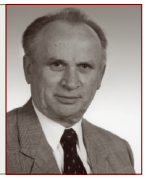
György Matolcsy
Minister of Economic Affairs

Zoltán Rockenbauer
Minister of National
Cultural Heritage

István Stumpf
Minister in charge
of the Prime Minister's Office

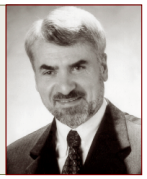
Ferenc Glatz
President of HAS

András Lipták
Member of HAS
President of NSRF



István Bihari
President of NTCD

József Pálinkás
Member of HAS, Chairman
of the Science Advisory Board



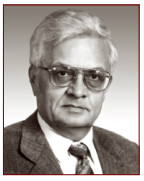
12 science & business experts — 14 government experts

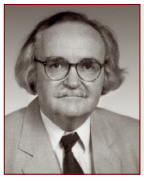
Dénes Dudits
Member of HAS, Director General
BRC of HAS, Szeged

István Fodor
President, Ericsson
Telecommunications Ltd., Hungary

János Gergely
Member of HAS, Professor
Eötvös Loránd University, Budapest

Kálmán Győry
Member of HAS, Professor
University of Debrecen



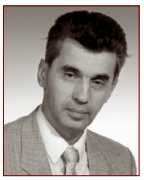


László Kósa
Member of HAS, Professor
Eötvös Loránd University, Budapest

János Pakucs
President
Hungarian Innovation Assocation

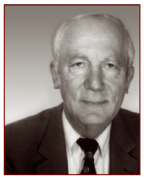
Károly Méhes
Member of HAS, Professor
University of Pécs

Tamás Roska
Member of HAS
CARI of HAS



Ernő Pungor
Member of HAS
Director-General, ZBFAR

Imre Somody
President and General Manager
Pharmavit-Bristol Myers Squibb Co.



Frigyes Solymosi
Member of HAS, Professor
University of Szeged

INTRODUCTION

The key to Hungary's advancement is competitiveness, and the fostering of social and economic conditions which encourage this. International experience shows that players are only successful when they can achieve high-standard innovation and bring to the market new products with a high intellectual input, as in the case of Ireland and Finland. Modern economies in the 21st century will be based on knowledge. In accordance with the programs of the European Union, Hungary's objectives are to

- improve the quality of life of its citizens,
- strengthen socially, economically and environmentally sustainable development,
- foster competitiveness,
- iron out differences in regional development,
- increase well-paid employment in services and in the production of knowledge-intensive, high-value-added goods.

Under the circumstances of today's strong economic competition, which takes place in a global arena, governments have to provide support not only for science, but also for technological development, and – from time to time – they have to formulate their science and technology policies.

This document summarizes the actions required to achieve Hungary's overall objectives in science and technology policy. Its range necessarily covers the field of higher education – from the standpoints of training and research alike –, and also the research institutes of the Hungarian Academy of Sciences (HAS) and the various ministries, along with the research facilities of the business sector. The definitions used in this document are the same as those in the *Frascati* and *Oslo Manuals* of the OECD.

The goal of *science and technology policy* is to optimize the use of our *resources and means,* taking into consideration the country's endowments, its economic and social needs and the opportunities provided by international co-operation. This policy has to facilitate the efficient utilization of the country's research and development potential nationally and internationally. It has to establish *preferences* for some fields and identify breakaway areas where the country's endowments and opportunities are better than average. These preferential areas, which manifest themselves in *national research and development programs,* offer the most promising fields for strengthening our economy and improving the quality of life. These *programs* obviously require *additional financial resources,* but their preferential status does not imply withdrawing resources from other fields. In the priority fields it is also a goal to achieve better co-operation in the practical application of research and development results than is typical at present. More active links between the players can help raise the present 37.7 per cent share of the private sector in total R&D expenditure to at least 50 per cent, thus coming closer to the 55-80 per cent usual in the developed economies.

Science and Technology Policy 2000 relies on the opinions and comments of a wide range of people in the research and development community. It takes into account the recommendations of the *World Conference on Science* held in Budapest in 1999 and organized jointly by UNESCO and ICSU. It also bears in mind the priorities of the European Union's *Research, Technology, Development and Demonstration Framework Program,* the EU's *White Paper of 2000,* OECD guidelines, and the documents envisaging a European Research Area.

The document gives an overview of the present situation in five areas, namely *human resources, institutional structure, financing, infrastructure,* and *international relations.* Based on these, it outlines the common goals and tasks for the major R&D stakeholders (e.g., the research community, government and industry). The five areas naturally overlap (e.g., human resources and institutional structure). The most important goal is to increase substantially the research and development funds that are available on a competitive basis and – as a part of the Széchenyi Plan – to launch a new national research and development program. Another high priority goal is to raise the salaries of researchers and college/university faculty, and to create a career model for researchers and teaching staff.

I. HUNGARIAN RESEARCH AND DEVELOPMENT AND CONTEMPORARY CHALLENGES

In the knowledge-based economy of the 21st century only a competitively trained, morally and culturally strong society will be able to improve the quality of life of its members and to increase the chances of the country's success. In such a society knowledge and creativity will play a decisive role.

1. Human resources

1.1. Present situation

In 1998 the number of researchers in Hungary was 11,731 (adjusted to represent full-time equivalent; *source:* Hungarian Central Statistical Office – HCSO). The indicator of 11 researchers per 10,000 head of population is low in comparison not only with the Western European average, but also with the indicators of countries on the same level of development as us. One obvious reason for the decrease in the number of researchers in past years has been the low level of salaries. But in spite of this, in a number of fields of basic science and in applied research and development top-quality research is done in the country. At the same time it is a fact that the knowledge transfer between higher education and industry is unsatisfactory.

The increase in the average age of researchers and teaching staff is alarming. The supply of senior teaching staff and researchers is "inbred". Considering these negative aspects, it is an achievement that the introduction of PhD training and the establishment of doctoral schools have initiated favorable processes.

1.2. Goals and agenda

It is essential to prevent deterioration in the standard of public education, and, in conjunction with this, to support the development of the network of quality high schools.

The principles of quality, excellence and scientific merit should be enforced more strongly in research and development. For young talents opportunities for a scientific career have to be provided here in Hungary. To this end, the number of PhD students should be increased; and in order to improve the supply of faculty, attractive postdoctoral programs should be introduced. In the fields of natural and technical sciences PhD training must be brought more into line with the needs of industry. Companies should be encouraged to establish Ph.D scholarships, as is usual in the developed economies.

The flow of knowledge and mobility between research institutes, higher education and industry should be stimulated.

2. Institutional structure

2.1. Present situation

The institutional structure of Hungarian research and development consists of the following main components:

- institutions of higher education,
- research institutes of the Hungarian Academy of Sciences and the Academy's research groups operating in universities,
- research and development institutes belonging to ministries,
- institutes of the Zoltán Bay Foundation for Applied Research,
- company research and development units.

A substantial part of Hungarian research and development capacity is to be found in higher education institutions. The quality of research at those institutions is uneven, though a number of outstanding results have been achieved. Unevenness in quality of research at the institutes of the HAS is less and the majority of the units perform well. Research groups established by the HAS at universities are useful players in university research. The capacity of scientific institutes funded by ministries is relatively small, except at those in the field of agricultural research. The number of

company research centers is low. The links between companies and the research units of universities and those of the Academy are weak, except in the fields of agriculture, food industry and forestry. The bodies taking part in the control of the research network are insufficiently independent of the institutions they monitor. The statistical data on company research spending, which forms part of total research expenditure, is inaccurate, which makes it difficult to assess total research expenditure accurately.

At many places the basic infrastructure needed for the given research has been built up. There are acknowledged and competitive research units in Hungary which have become parts of international research networks. There is no need to reorganize the institutional structure.

2.2. Goals and agenda

Research institutes representing assets of national importance and serving national interests should continue to be maintained by the state in the future. The *research networks of the HAS and the ministries represent national assets* and must be preserved. The successful system of university research groups has to be developed further. Continuous monitoring of the operation of the research institutions funded from the state budget should also be a part of the maintenance and operation of research institutions.

Regional unevenness in the distribution of research and development capacities should be reduced.

In the medium term it is desirable to change the inner composition of research capacities, with research capacities in life sciences growing more vigorously.

The research and development capabilities of most small and medium-sized enterprises (SMEs) should be strengthened. SMEs have to be helped to apply research results and to utilize them to expand their markets. The state should play a role in this.

The establishment and enlargement of research and development laboratories of large international and national enterprises should be supported.

In fields of strategic importance *national research and development programs* should be launched on the basis of competitive funding.

The research institutes of the Academy, the universities and companies should be encouraged to engage in joint research. To foster joint activities, *research-education-technology centers* have to be established. In certain cases, technology transfer needs to be supported by the state.

Guarantees of utilization of results and of the assertion of intellectual property rights in research and development should be established.

3. Financing

3.1. Present situation

Many elements in the financing of research and development in Hungary were developed under conditions radically different from those of today. Average salaries of researchers and faculty are low. The money is distributed rather diffusely and, at the same time, its allocation is insufficiently performance based. The present situation has emerged as a result of incoherent and *ad hoc* adjustments to the salaries of public employees.

More than half of Hungary's research capacity is concentrated in Budapest, and most of the funds for its development are spent there also. More than 60 per cent of total research and development expenditure is provided from the state budget and the use of these resources is fragmented. The social sciences share of state research support is larger and the life sciences share smaller in Hungary than in the developed countries.

3.2. Goals and agenda

Total research and development expenditure should reach 1.5 per cent of GDP by the year 2002, while the R&D expenditure of the private sector should increase to at least 50 per cent of the whole.

Budgetary support for the National Science Research Fund (NSRF) has to be substantially increased. The profiles of schemes inviting applications for research support should be made clearer. The sizes of the administering organizations must be rationalized and the application processes made more efficient. To strengthen applied research and development, alternatives should be worked out for a rational revitalization of the National Technological Development Fund (NTDF). It is desirable that expenditures on basic research be at least 20-25 per cent of total R&D spending. The allocation procedure for research funds should provide opportunities to grant untypically large sums to researchers who perform outstandingly well.

The system of the dual-channel state financing of research and development based on institutional financing and competitive project funding has to be preserved. The basic financing of research institutions should be guaranteed. The proportion of normative support for research in higher education has to be substantially increased within the full normative funding. At state-financed research institutions a monitoring system for registering and assessing scientific performance should be developed.

A general salaries reform should be carried out based on unified and objective criteria. This has to be bound up with the fixing of the number of research and teaching staff at each institution. As a first step, starting in 2001, a system of position-dependent allowances (bonuses) should be introduced in research institutes, in line with the practice at higher education institutions. Later on, a new, performance-related, career model should be developed for senior faculty members and researchers – a model that will be attractive for younger generations.

4. Infrastructure

4.1. Present situation

The state of the scientific equipment park – one of the key requisites for research – is inadequate. There is an urgent need that new equipment be acquired for the institutions. At the same time the maintenance, operation and repair of existing equipment also pose problems.

Routine acquisition of basic literature for specialized libraries is becoming more and more difficult. In the 1980s and 1990s subscriptions to a number of important international scientific journals had to be canceled. The informatics systems of some specialized libraries are uneven in quality and are incompatible with one another. On the other hand, the National Information Infrastructure Development Program has eased these burdens to some extent by providing a high-performance network for information exchange. The computer network is under further development through the connection of new users to the system. Databases can be accessed through the Internet from most scientific libraries.

4.2. Goals and agenda

In accordance with the national research and development programs, a program for purchasing new scientific equipment should be launched to replace and modernize outdated research equipment. An increased rate of annual amortization should be introduced for research apparatus and fittings.

A library development program needs to be initiated at higher education and research institutes to increase their holdings and facilitate a concerted acquisitions policy. Two goals should be the gradual upgrading of their electronic information systems and the development of their digital holdings. Subscriptions to digital journals should be harmonized at national level. The National Information Infrastructure Development Program must provide for a broader range of electronically-accessible databases and for keeping pace with state-of-the-art international network developments. The basic journals in all scientific fields need to be accessible in the libraries.

Financial support should be provided for state-financed research institutions to enable them to acquire standard quality-control certificates.

5. International co-operation

5.1. Present situation

During the past decades a substantial number of bilateral and multilateral collaborations have developed at institutional, Academy and governmental level. Hungary has become a full member of most important pan-European research and development organizations. The European Union has evaluated the state of Hungarian research and development as being ready for accession, and Hungary already takes part in the EU's 5th RDT Framework Program as a full member.

A number of Hungarian researchers work on mega-science projects at large research facilities abroad. Participation in such programs requires that those taking part contribute to the financing of the programs. This has often caused difficulties for Hungary. The money accruing from international research and development co-operation has, however, assisted only mobility.

5.2. Goals and agenda

Mainly those international ties need to be strengthened which will enable us to learn and adopt methods of utilizing research findings commercially. In the course of international co-operation, Hungarian interests in the fields of intellectual property rights, national security and the economy should be pursued and protected.

When engaging in bilateral intergovernmental research collaboration, not only support for mobility, but also funds for the conduct of worthwhile research and development work should be secured.

Dedicated funds should be allocated for membership fees for large international organizations and national research contributions to major international projects. Chances for Hungarian researchers to take part in large, mission-oriented international programs need to be improved.

Hungary should strive to become a regional center for research and development in certain fields. To attract as many foreign researchers to Hungary as possible, the conditions for establishing Albert Szent-Györgyi Scholarships – on the lines of Germany's Humboldt Scholarships – have to be worked out. Existing bilateral agreements for student and researcher exchanges should be changed to accord with these scholarships.

It is important that senior Hungarian researchers be duly represented in committees approving international research applications and in the science policy decision-making bodies of international programs and organizations.

A) National research and development programs

In a small country like Hungary establishing priorities is a must. Focusing efforts is the only way to reach the critical scientific mass required for economic utilization of research results, for finding niches in the world market for new products, and for establishing regional scientific centers. Setting priorities has resulted in new programs that are mostly interdisciplinary as well as integratory; at the same time they are promising from the economic development point of view and will have a long-term impact. As the "building blocks" of these new programs, concrete thematic priorities have been defined. This document proposes five national research and development programs to enhance economic competitiveness and to contribute to the achievement of social objectives in a broader sense. By Governmental Resolution 1073/2000 (VIII.31.), the Hungarian Government approved the launch of the national research and development programs and established the legal framework for their implementation.

Program 1 – Improving the quality of life

The physical and intellectual condition of its citizenry is a decisive factor in the vitality of a nation. In the developed countries the health industry is one of the motors of the economy. Education, national culture, healthcare, and the smooth functioning of society are important factors in competitiveness. Hungary has a great tradition and internationally recognized experts in the fields of medical sciences, pharmaceutical research, molecular biology, agriculture, materials sciences, and gene technology. Most Hungarian pharmaceutical companies are owned and operated by major multinational healthcare companies. In addition, in the last years a number of small companies have emerged in Hungary which have specialized in one or two promising products which hold out the prospect of large profits for venture capital.

To reach good intellectual condition and a good social atmosphere, it is indispensable to expose problems in a way that is precise scientifically. Therefore, this national program has to involve some important social research, even when these research projects are related to medium- and long-term economic goals only indirectly.

Main program fields

- Biomedical research with special emphasis on the application of the techniques of molecular biology,
- new methods of health preservation and prophylaxis along with advances in rehabilitation,
- pharmaceutical research using molecular techniques,
- functional genomics,
- research into social hygiene, health policy and economic aspects of healthcare,
- sustainable mobility.

Program 2 – Information and communications technologies

Research and development in communication and information technologies are among the most important fields of technological progress worldwide. This sector makes up a very substantial part of the world economy. It is growing dynamically, and is transforming not only national economies but everyday life as well. We are witnessing the emergence of a brand-new, interdisciplinary industry. There are many small and medium-sized Hungarian companies which are able to produce high-tech goods in this field. It is desirable that these companies join and hence strengthen the supply network of international companies operating in Hungary, thereby reducing the technological gap between Hungarian industry and the international leading edge.

Owing to the traditionally high quality of education in the field, Hungary has considerable research potential in mathematics. There are outstanding results in some fields of applied research, and Hungary is already well placed for the development of special software. Some fields requiring special knowledge could become driving forces for research and development in the country.

Main program fields

- Integrated intelligent sensors,
- development of devices and methods for human language technologies,
- mobile and integrated telecommunications networks,
- application of analogue computation techniques and telepresence,
- application of molecular-level information technologies,
- telematics for intelligent transportation systems.

Program 3 – Environmental and materials research

It is well known that the exhaustion of raw material resources, and especially of fossil fuels, poses an ever-growing challenge worldwide. The spread of environmental pollution and the alarming degradation of biodiversity constitute a similar challenge. As far as the state of the environment is concerned, Hungary lags even further behind the developed countries than it does economically. At the same time, Hungary has considerable traditions and research potential in theoretical and applied ecology. Through the development of new materials and the introduction of new technologies environmental pollution can be significantly reduced, and recycling achieved on a larger scale.

There are a number of institutes in Hungary that conduct top-quality research into new materials on which a national program can be based. With focused and increased financing for a few carefully chosen specific areas, new industries can be established or revitalized, industries utilizing results in electronics, computer technologies and telecommunication technologies, as well as industries in certain fields of life sciences and materials sciences.

Main program fields

- Ecological research,
- detection and neutralization of environmentally polluting materials, and the working out of programs to decrease pollution,
- utilization of raw materials found in Hungary,
- utilization of new energy resources and energy-saving technologies,
- production of new materials and research into environmental-friendly materials,
- nanotechnology: manufacturing and analysis of materials on the molecular level,
- research on environmental aspects of transportation and water management.

Program 4 – Research on agribusiness and biotechnology

Agriculture plays a determinant role worldwide not only in supplying food to the population, but also in protecting and shaping the environment. Hungary's potential favors food production. While preparing for accession to the European Union, the state of Hungarian agriculture should be changed for the better. Special attention has to be paid to the improvement of the quality of the land, which – because it is irreplaceable – is a very special national asset. Protection and utilization of rare animal and plant species should also be a goal.

Increased financing of agricultural and biotechnology research will provide an opportunity to increase the added intellectual value of Hungarian agricultural and food industry products, to improve their quality, to boost their sale abroad, to protect the environment, and to raise the standard of living in the countryside.

Main program fields

- Animal and plant breeding using molecular techniques: research on functional genomics,
- research into enhancing farm, forest and game management,
- research into animal hygiene and plant protection,
- research into competitiveness and the effects of Hungary's accession to the European Union in the field of agribusiness,
- research and development concerning food industry technologies and food safety.

Program 5 – Research on national heritage and contemporary social challenges

At their highest levels the country's human resources are as good as any in the world, but at middle level they fail to match those in Western Europe. The reasons for this lagging behind are to be found in social conditions and education. It is important that public education includes the promotion of ambition and the teaching of foreign languages. An important issue in science policy is therefore to support the social sciences, and, within these, research into national traditions. There are top-quality scientific institutes in this field; nevertheless there is substantial work still to be done in the investigation of the Hungarian cultural heritage.

Both national and European consciousness need to be strengthened in the minds of the Hungarian people. The country can only become a successful member of the European Union if both are reinforced. For this reason, studying the history of Hungary's society, literature, culture, art, and language is crucially important, as is the study of Hungarian ethnography and sociology. Within these the study of sources is of fundamental importance.

Main program fields

- Hungarian culture in European integration and other international processes: Hungary's embedment in Europe, regional and local particularities, the state of the Hungarian language and the image of the Hungarians abroad,
- the national minorities issue in theory and practice, in particular its historical, legal, sociological and political aspects,
- study of the mental and moral state of society, social habits and identity,
- exploration of the physical and intellectual values in the cultural heritage and their publication to a broad public,
- research into the integration of Gypsies into society.

B.) Implementation of the technology policy

Most of the main areas in the national research and development programs are suitable for accommodating basic research, applied research and technology development. The technology policy of the Government should facilitate and stimulate capital investments to be directed into knowledge-intensive *high-tech sectors* that turn out high-value-added and environment-friendly products. The practical application of results of research and development in the so-called *medium* and *low technologies,* which may still be acceptably competitive, will fall to the enterprises themselves. The development and dissemination of these technologies have to be stimulated indirectly through so-called *horizontal means* and activities in a sector-neutral manner, avoiding the distortion of market and competition. These horizontal means, which combined with the first four national research programs are to enhance the innovation activity of the business sector, are as follows:

1. Strengthening co-operation between research and development institutions and the business sector

Establishment of *centers of innovation and information* that foster the competitiveness of the business sector and its co-operation with the research institutes. The main target-activities: the dissemination and putting into general use of methods of innovation management and consulting, etc.

Main elements

- Elaboration of a support scheme for establishing and strengthening knowledge- and technology-intensive enterprises that start up at research institutes;
- Stimulation of co-operation in innovation between domestic companies, especially the small and medium-sized ones. To this end, horizontal target-oriented projects should be launched. The Government has to play a greater role in these programs as an awarder of contracts;
- Initiation of target-oriented application schemes that are to stimulate technology transfer through co-operation between small and medium-sized enterprises and domestic research and development institutions.

2. Enhancing the innovation capability of the entrepreneurial sphere

The innovation capability of small and medium-sized enterprises should be strengthened. In the allocation of state research and development resources special attention needs to be paid to encouraging the more efficient use of existing research and development capacities, to increasing the funds for technology investment, and to encouraging knowledge and technology transfer.

Main elements

- Elaboration and initiation of target-oriented application schemes that complement national research and development programs and that are aimed at the technology development phase of the innovation process;

- Review of the economic incentive schemes to simplify them and thereby create an economic environment that favors innovation. The current 120 per cent writing off of R&D expenditure as cost should be increased to 200 per cent. Moreover, a higher rate of amortization for equipment used in the innovation process should be made possible;
- Preferential treatment needs to be given in research and development support schemes to small and medium-sized enterprises, in compliance with the competition regulations of the European Union;
- Changing incentives to direct "seed capital" to innovative start-up companies and venture capital to technology-intensive investments;
- Hungary should be made attractive as a research and development location for multinational companies;
- Small and medium-sized enterprises should be assisted in employing graduate personnel.

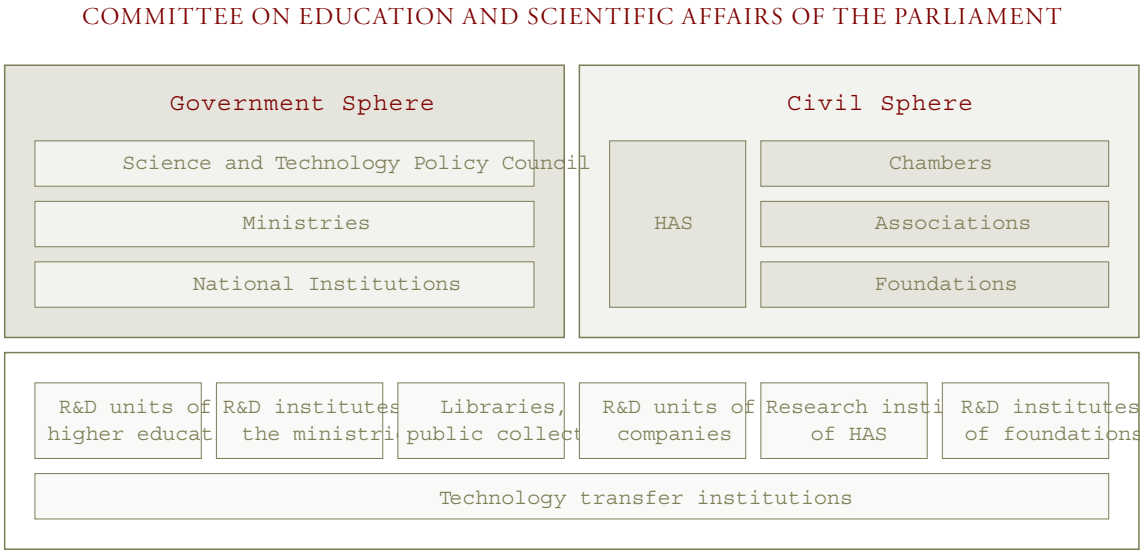
3. Regional innovation

The economic development programs of the regions of the country should contain – as one element – a regional innovation strategy which requires target-oriented co-operation between the governmental and the business sectors.

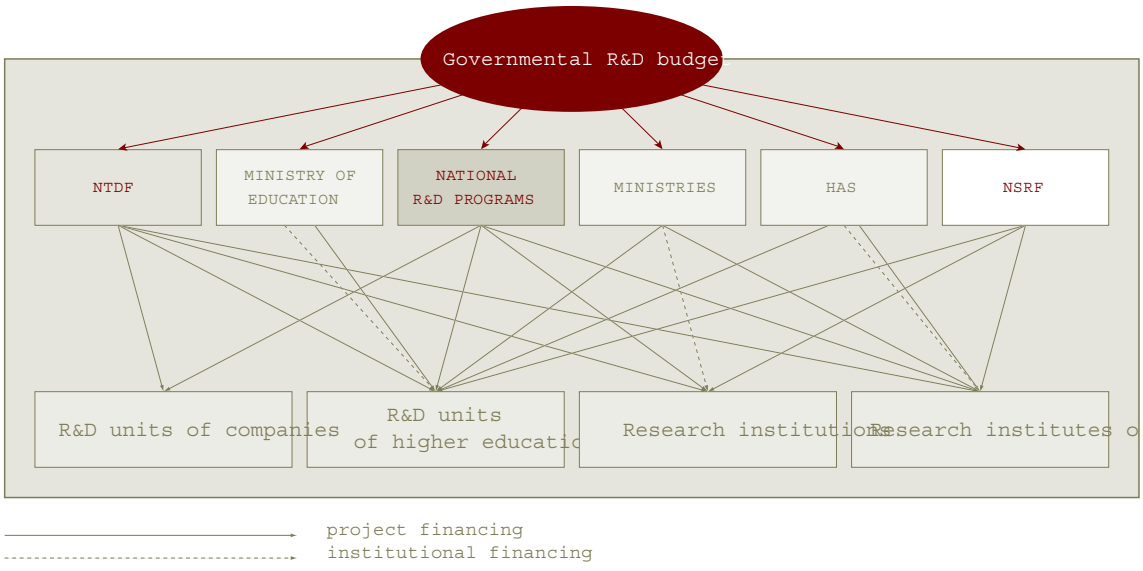
Main elements

- The institutional system of regional innovation has to be strengthened, through the co-operation of central governments, local governments, regional institutions, and business partners. At the same time, the existing business networks in the region should be complemented with innovation elements;
- Hungary has to prepare itself to use the EU's structural funds for innovation purposes, and to this end regional innovation development programs should be started to increase the "take up" of these innovation funds;
- Innovation partnerships of regions spanning state borders should be strengthened.

Hungarian research and development system

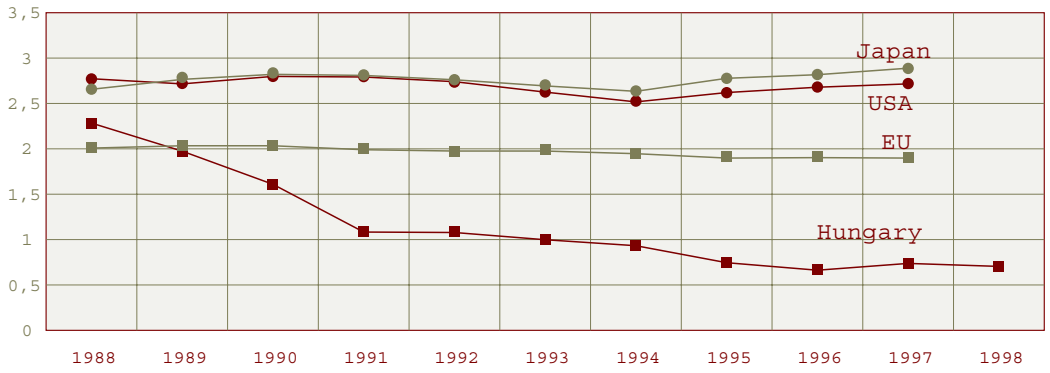


There are some overlaps in the state R&D financing of institutions and projects



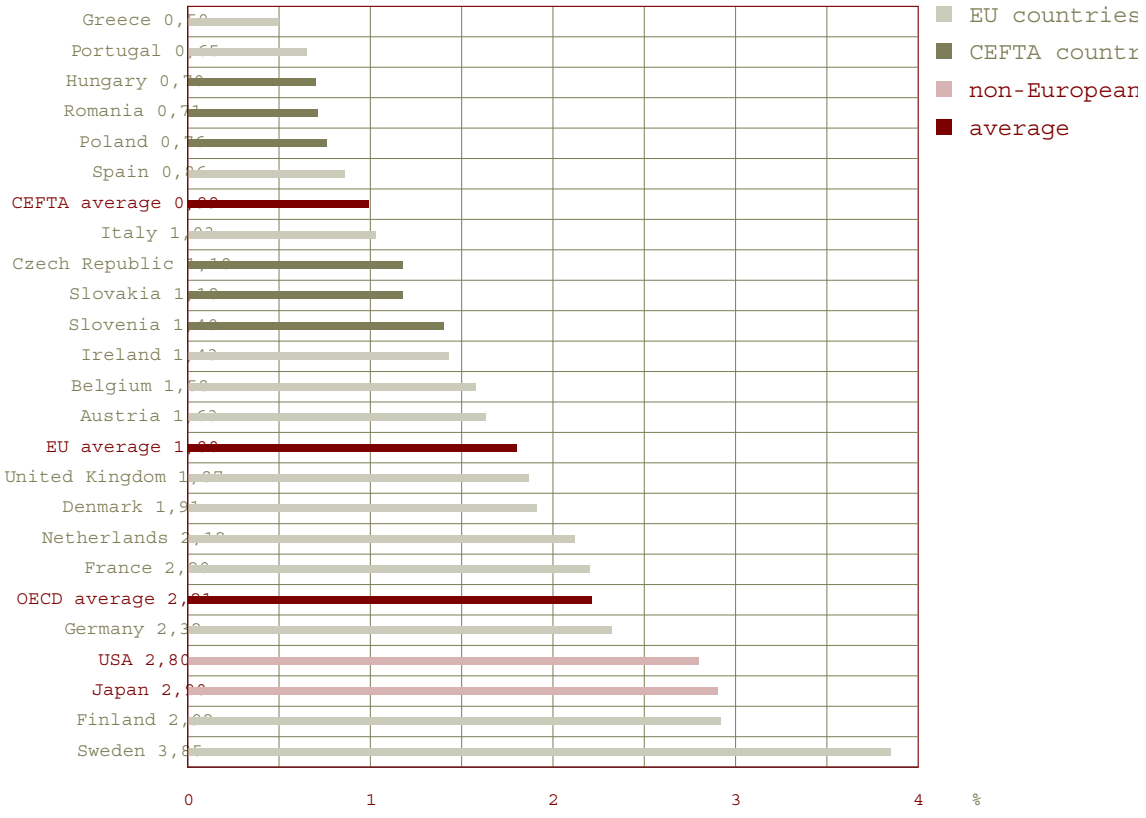
The GERD as a percentage of GDP has decreased substantially during the past ten years, and lags significantly behind the expenditures of developed economies. (Sources: Eurostat, HCSO)

R&D EXPENDITURES IN PERCENTAGES



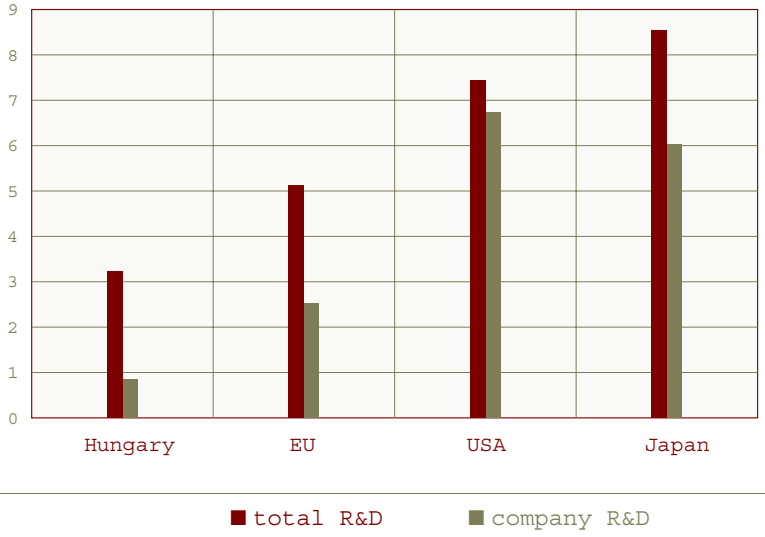
The R&D expenditures of different EU countries vary significantly. With its present expenditure, Hungary ranks between Portugal and Spain. The Hungarian R&D expenditure is low even compared to CEFTA countries. (Source: Eurostat, OECD, HCSO)

RESEARCH AND DEVELOPMENT EXPENDITURE AS A PERCENTAGE OF GDP IN 1998



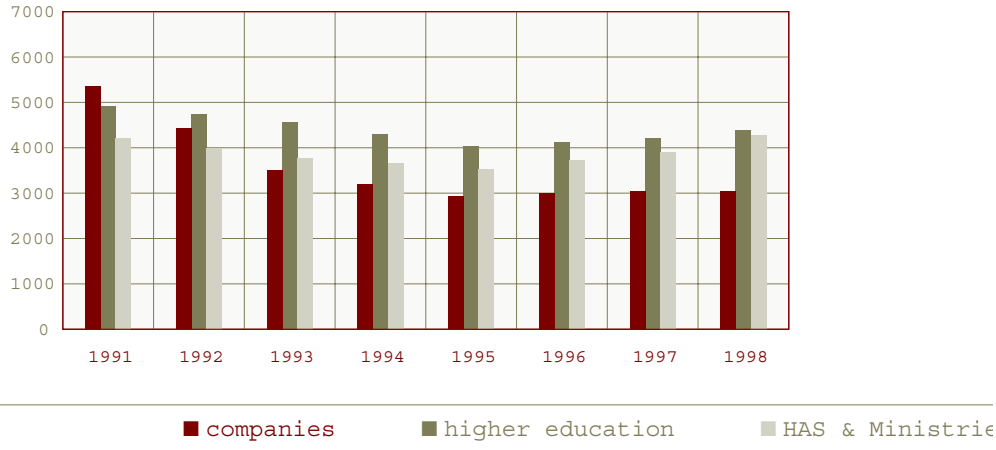
The number of personnel engaged in research in Hungary lags substantially behind not only the USA and Japan, but also the average of the EU countries, which is lower. In comparison with these three economic centres, the gap is even bigger with regard to the number of researchers working at companies. (Source: EU, HCSO)

NUMBER OF RESEARCHERS PER 1,000 HEAD OF WORKFORCE



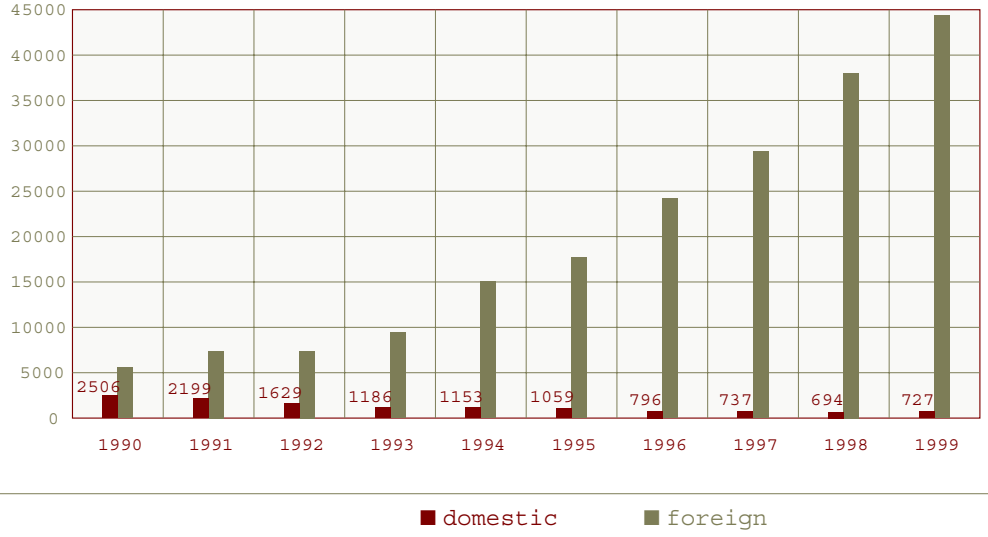
In the past years the total number of personnel engaged in R&D has been slowly growing. In spite of the R&D laboratories established by multinational companies in Hungary, the growth of company indicators is not yet noticeable. (Source: HCSO)

NUMBER OF R&D PERSONNEL BY SECTOR



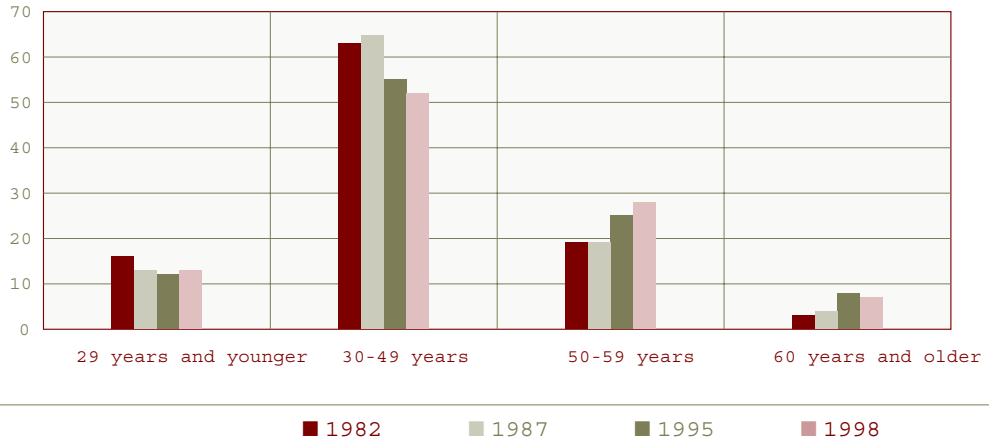
In the 1990s, while the number of patents registered in Hungary grew dynamically, the decrease in the number of patents of domestic origin was alarming. 1999 was the first year of the decade when a slight increase occurred. (Source: HPO)

NUMBER OF REGISTERED PATENTS IN HUNGARY



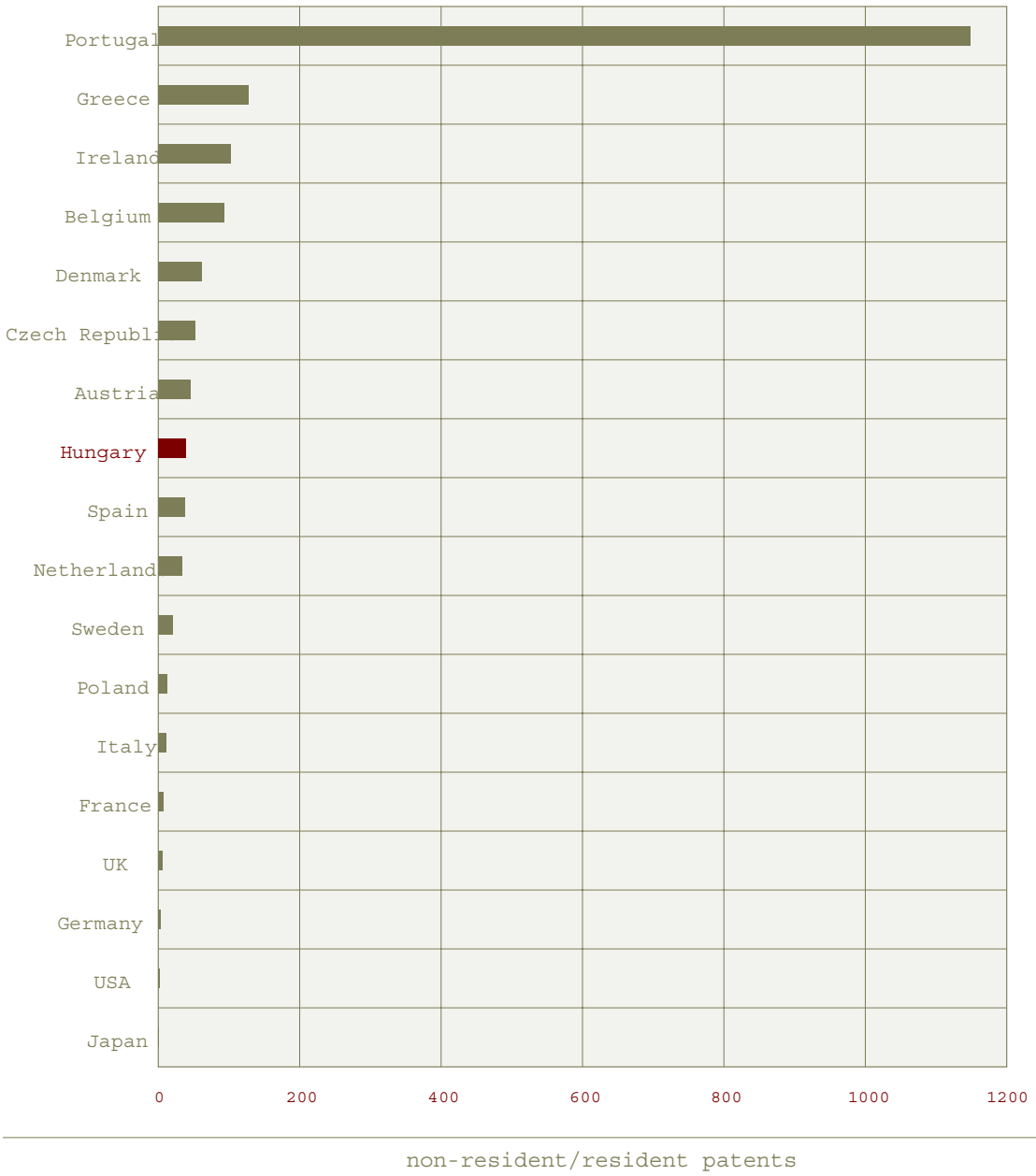
In the 1980s and 1990s – mainly because of poor salaries – the supply of researchers diminished and the average age of R&D personnel grew rapidly. (Source: HCSO)

DISTRIBUTION OF RESEARCHERS BY AGE GROUPS, AS PERCENTAGES



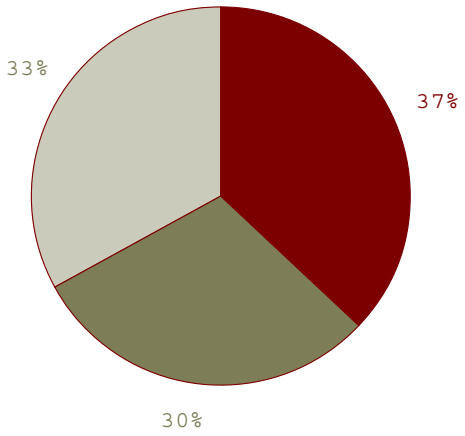
The technological position of a country is well described by the so-called dependence index, which shows the ratio of foreign and domestic patents registered in the country. The Hungarian economy's dependence on the patenting activities of certain countries (e.g., USA, Germany, Japan, United Kingdom) is significant. At the same time, Hungary enjoys a relatively good position among the European countries of approximately similar size. Austria with a significantly stronger economy and Spain with much larger territory have approximately the same dependence index as Hungary. (Source: HCSO, OECD)

DEPENDENCE INDEX

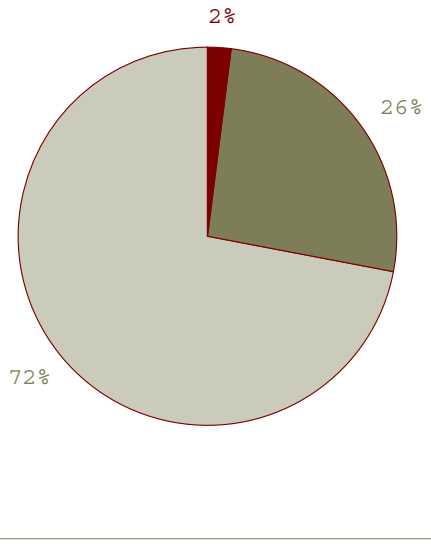


While the share in total R&D expenditure of the three major research types is quite balanced, the share of basic research in company R&D expenditure is insignificant. (Source: HCSO)

GROSS EXPENDITURE ON R&D (1999)

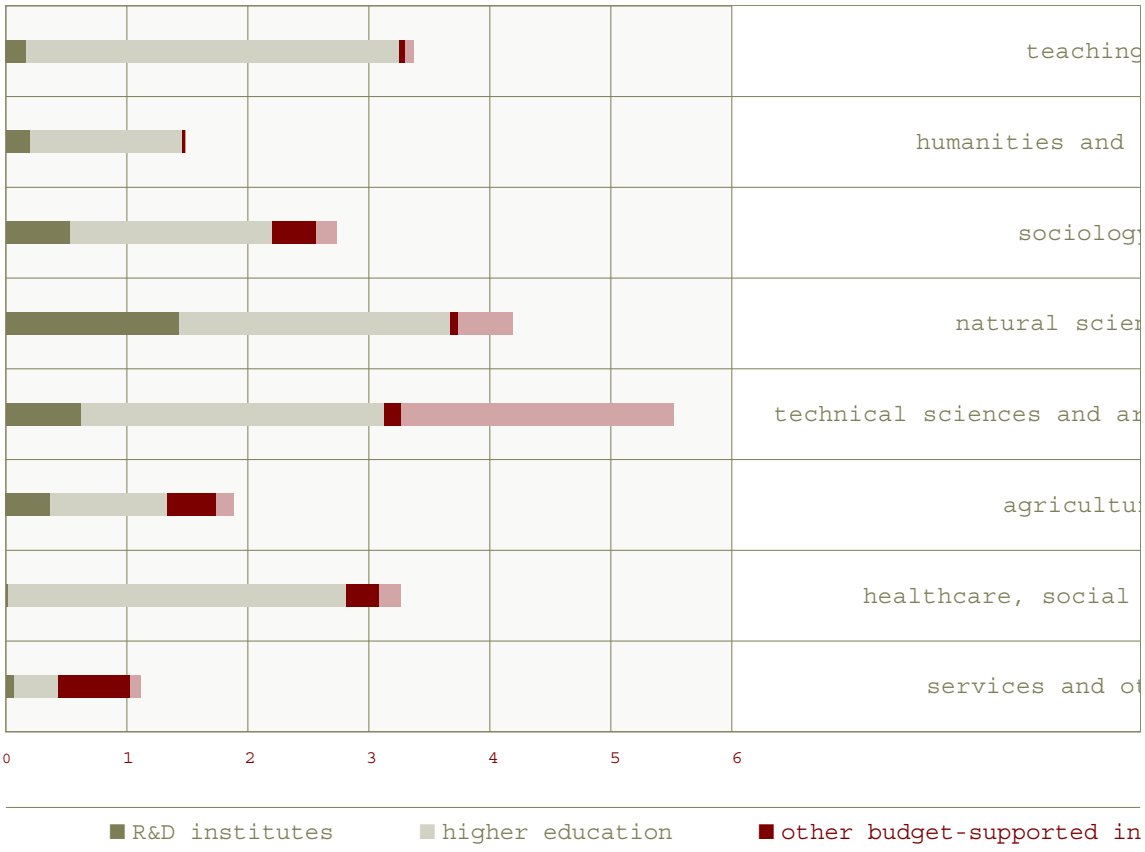


COMPANY R&D EXPENDITURE (1999)



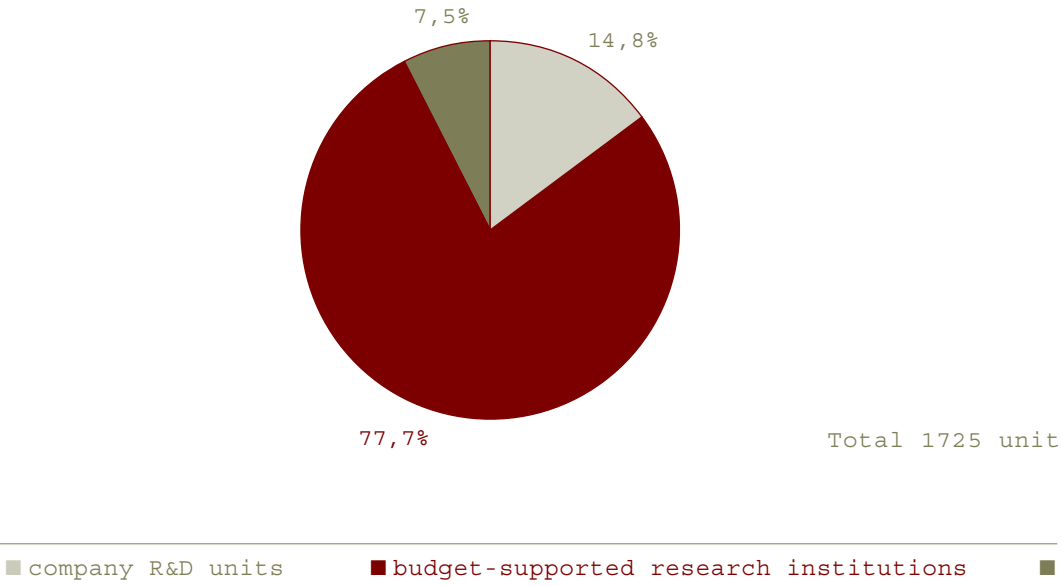
Of those persons with a higher education degree, it is mainly those with technical education who feature in the entrepreneurial sector. For those with a university/college degree in natural sciences, the business sector is not yet sufficiently attractive. (Source: HCSO)

COMPOSITION OF THE RESEARCH WORKFORCE BY EDUCATION IN HUNGARY, 1998 (THOUSANDS)



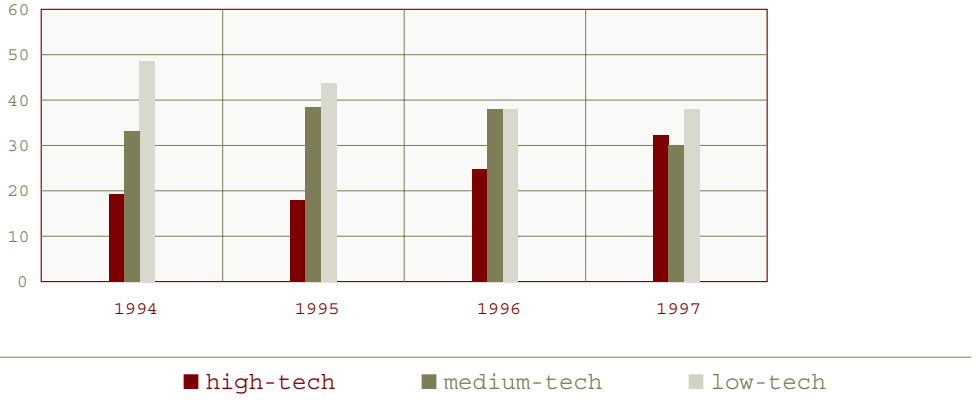
If we sort Hungarian research and development units by legal form, we find that most of them are state-maintained (budget-supported) institutions.

R&D UNITS BY LEGAL FORM OF ORGANIZATION (1998)



In the 1990s - mainly owing to the investments of multinational companies and their R&D activities in Hungary - the share of high-tech products in the exports of Hungarian manufacturing industry grew. (Source: ECOSTAT)

THE SHARE OF HIGH-TECH PRODUCTS IN HUNGARIAN MANUFACTURING EXPORTS (%)



The largest component of the Hungarian R&D system is higher education. The formerly unintegrated, strongly specialized universities with narrow profiles were transformed into integrated, multidisciplinary universities in accordance with Law LII of 1999. This provided the opportunity to increase the number of students, broaden curricula, reach an intellectually critical mass, and establish research centres of international significance.

HIGHER EDUCATION - STATE UNIVERSITIES

1. Budapest University of Economic Sciences and Public Administration
2. Budapest University of Technology and Economics
3. University of Debrecen
4. Eötvös Loránd University, Budapest
5. University of Kaposvár
6. Ferenc Liszt Musicology University, Budapest
7. Hungarian University of Craft and Design, Budapest
8. Hungarian University of Arts, Budapest
9. University of Miskolc
10. University of Western Hungary, Sopron
11. University of Pécs
12. Semmelweis University, Budapest
13. University of Szeged
14. University of St. Stephen, Gödöllő
15. University of Veszprém
16. Miklós Zrínyi University of Defense, Budapest
17. Academy of Drama and Film, Budapest

Budapest University of Technology and Economics

University of Pécs

University of Debrecen

University of Szeged

Eötvös Loránd University, Budapest

University of St. Stephen, Gödöllő

The Hungarian Academy of Sciences (hereinafter HAS) was founded in 1825. In accordance with Law XL of 1994 the HAS is an independent public body based on the principle of self-government with the mission of cultivating, supporting and representing Hungarian science. Since their restructuring the research institutes operate in a reformed institutional set up with renewed goals.

RESEARCH AND DEVELOPMENT INSTITUTES OF THE HAS BY SCIENTIFIC FIELDS

Natural sciences and mathematics	Life sciences	Social sciences including humanities
Alfréd Rényi Mathematical Institute	Agricultural Research Institute	Archeological Institute
Astronomical Research Institute	Balaton Limnological Research Institute	Etnographical Research Institute
Chemical Research Center	Institute of Ecology and Botany	Institute of History
Computer and Automation Research Institute	Institute of Experimental Medicine	Institute for Legal Studies
Institute of Nuclear Research	Research Institute of Plant Protection	Institute for Literary Studies
KFKI Atomic Energy Research Institute	Research Institute for Soil Science and Agricultural Chemistry	Institute for Musicology
KFKI Solid State Physics and Optics	The Szeged Biological Research Center	Institute of Philiosophy
KFKI Research Institute for Particle and Nuclear Physics	Veterinary Medical Research Institute	Institute for Psychology
Research Center for the Earth Sciences		Institute of Sociology
Research Institute for Technical Physics and Materials Science		Research Institute for Art History
		Research Institute for Linguistics
		Centre for Regional Studies
		Institute of Economics
		Institute for Political Sciences
		Institute for World Economics

There are many indicators for measuring research institutes and their performance. Among them are number of researchers, their output (publications, patents), and data on financial support, etc.

MAIN INDICATORS OF RESEARCH UNITS (1999)

	Research institutes total	HAS	R&D units of higher education	Other budget supported institutions	Company research units
Total staff numbers	6359	4069	24411	3636	7682
Number of researchers	3201	2308	15456	1889	4063
Proportion of researchers (%)	50	57	63	52	50
Total FTE [1]	5079	3516	7452	2899	5899
FTE researchers [1]	2904	2167	4768	1646	3261
FTE proportion of researchers [1] (%)	57	62	64	57	55
Members of HAS	70	67	182	18	2
Persons with scientific degree [2]	1365	1105	5614	491	322
Foreign researchers [3]	12	9	225	-	31
Postgraduate students	216	174	3895	92	-
Books published in Hungarian	283	194	2073	445	27
Articles published in Hungarian	2364	1474	11642	2050	754
Books published in foreign languages	162	132	547	78	12
Articles published in foreign languages	2382	1991	8576	1661	272
Domestic patents	42	8	55	4	58
Foreign patents	-	-	57	1	117
Research topics	3748	2513	9285	1267	6644
International co-operations	407	349	888	162	244
R&D costs (M HUF) [5]	17676	11579	1589	4464	23457
Budget support for projects [4] (M HUF)	5689	3231	4190	1329	1399
Central budget (M HUF)	8588	391	1904	2435	-
Cost of personnel (M HUF)	9270	6551	8689	2394	12162
Purchase of equipment (M HUF)	1907	1271	1424	372	6415

1. Full-time equivalent

2. Doctors of Sciences and PhD

3. Visiting + permanent

4. Research funds of ministries, CTDF, NSRF

5. M HUF = Millions of Hungarian Forints

REFERENCES AND TERMINOLOGIES

References

OECD: The Frascati Manual ("*The Measurement of Scientific and Technological Activities.* Proposed Standard Practice for Surveys of Research and Experimental Development, Frascati Manual", 1993, Paris). Hungarian edition: 1996, OMFB.

OECD: The Oslo Manual ("Proposed Guidelines for Collecting and Interpreting Technological Innovation Data", 1992, Paris). Hungarian edition: 1994, The Prime Minister's Office.

OECD: The Canberra Manual ("Manual on the Measurement of Human Resources Devoted to S&T - Canberra Manual", 1995, Paris). Hungarian edition: 1999, OMFB.

Terminologies

Basic research: Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

Applied research: Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental development: Experimental development is systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

R&D (research and experimental development): Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

Technology: In one approach it means the method of production, the method of applying scientific knowledge (creating equipment and the organizational knowledge for operating it). In another approach technology means knowledge (codified or hidden), thus acquiring specific production processes and providing concrete problem-solving methods. Technology in its broader, anthropocentric sense means an organized system of humans and machines in which scientific knowledge and results are applied for solving practical problems.

Technology has three basic elements:

- information on the method of production and equipment,
- production equipment itself (embedded technology),
- methods and organizational knowledge required for operating equipment.

Technology transfer: It is generally accepted that technology transfer means much more than just the detailed technical documentation of a given product or production process. The transferred technology consists of all those intangible goods that are indispensable for operating equipment and manufacturing products, thus it comes with "sharing of knowledge".

Innovation (technological innovation)**:** It may be regarded as the transformation of an idea into:

- a new or improved product introduced into the market,
- a new or improved operational process used in industry and commerce,
- a new approach to a social service.

The word "innovation" has different meanings in different approaches. The exact definition depends on the concrete goal and subject of measurement or analysis. The Oslo Manual defines technological innovation as follows:

Technological innovations comprise new products and processes and significant technological changes in products and processes. An innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). Innovations therefore involve a series of scientific, technological, organizational, financial and commercial activities. R&D is only one of these activities and may be carried out at different phase of the innovation process, acting not only as the original source of invention ideas but also as a form of problem solving which can be called on at any point up to implementation.

ACRONYMS

ZBFAR: Zoltán Bay Foundation for Applied Research
BRC of HAS: Biological Research Center of the Hungarian Academy of Sciences, Szeged
HCSO: Hungarian Central Statistical Office
CARI of HAS: Computer and Automation Research Institute of HAS
HPO: Hungarian Patent Office
ECOSTAT: Institute for Economical Analysis and Informatics, Hungary

EU's Framework Program for Research, Technological Development and Demonstration Research Program of the European Union. The latest one is the 5th Framework Program with a timeframe of 1998-2002. Hungary joined the 5th FP as a full member in 1999.

HAS: The Hungarian Academy of Sciences was founded in 1825. In accordance with Law XL of 1994 the HAS is an independent public body based on the principle of self-government with the mission of cultivating, supporting and representing Hungarian science. Since their restructuring the research institutes have operated in a reformed institutional set up with renewed goals.

NSRF: National Science Research Fund (Framework Program). It was established in 1986 and was supervised by the Hungarian Academy of Sciences. Since 1991 it has operated as an independent organization. The mission of NSRF is to support scientific research, development of R&D infrastructure and the scientific work of young researchers. Laws XXII of 1993 and CXXXVI of 1997 provide the legal basis for its operation.

NTDF: National Technology Development Fund (Framework Program). Its goals are defined by Government Resolutions 74/1997 (IV. 39.) and 98/1996 (VII. 10.) as promoting technological innovation, development of R&D infrastructure, and the dissemination and economic application of research and development results.