ALLEA Working Group
"National Strategies of Research in Smaller European Countries"

RESEARCH STRATEGIES FOR SMALLER COUNTRIES

FINAL REPORT
to the ALLEA General Assembly
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PREFACE

In 1999, ALLEA has founded a Working Group in order to analyse national strategies of research in smaller European countries. It was a timely action because since 1999, science policy has been a widely discussed topic in Europe. The EU documents like "Towards a European Research Area" and Proposal for the 6th Framework Proposal (2002 – 2006) have encouraged both the member and candidate countries to revisit their research strategies and formulate their policies for the future. Many meetings have addressed this topic. The WG of ALLEA has been co-operating with the UNESCO Venice Office and other European Institutions. The first report of the WG has been prepared for the ALLEA General Assembly in Prague, 2000. This is the Final Report of the WG prepared for the ALLEA General Assembly in Rome, 2001.

I use this opportunity to thank all the members of the WG and the contributors for their efforts and also the UNESCO Venice Office for their support.

Jüri Engelbrecht

Chairman of the WG
Tallinn, December 2001

EXECUTIVE SUMMARY

The ALLEA WG National Strategies of Research in Smaller European Countries welcomes the activities of the EC, other European institutions, and national science policy-makers directed towards enhancing and consolidating research in Europe. Still, the views of different countries and the aims of researchers and society may differ. This means that a realistic way to move forward is to understand and accept the different views and to shape policy to support these views within the overall structure and general trends to strengthen the coherence of all activities in the long run.

The intention of the following recommendations is to inform the steps and measures to be taken by policy-makers. Based on its analyses, the ALLEA WG stresses the following.

1. The consolidation of national S&T strengths and the strengthening of a proper funding system for R&D is of primary importance for meeting national needs and for meeting the goal of a European research area.
   - Funding of national R&D at less than 1% of GDP can not influence the country's economy;
   - The ideas of setting up specific targets of R&D funding for the candidate countries like the long-term recommendation for member countries to reach 3% of GDP for R&D have been discussed widely.
2. Knowledge in the contemporary world is generated by science-driven, technology-driven, and issue-driven research.
   - The dialogue between science and society should be strengthened;
   - The role of academies includes not only enhancing science-driven research but also supporting other driving forces in order to meet society's needs.
3. R&D structures should rely on existing strengths.
   - The Centres of Excellence in Research and their networks should be supported;
   - Technological development needs strengthening through appropriate innovation structures;
   - Smaller countries should find a proper balance between their needs, possibilities and opportunities.
4. The mobility of researchers is vital for training purposes, the development of expertise, and knowledge transfer.
   - The goal of mobility is increased interaction; to encourage broad mobility and exchange, the visibility of smaller countries should be enhanced;
   - The role of governments is to encourage bottom-up initiatives to address societal needs;
   - The social security net for researchers visiting other countries needs full attention.

5. Co-operation in research means the better utilization of scientific potential, especially for smaller countries.
    - In addition to a European scale, co-operation should also involve regional activities;
    - The European co-operative research programmes should be flexible and give equal opportunity for participation by large and small countries;
    - Opening of national programmes of research is to be supported.
6. All incentives for the stimulation of young people in S&T should be supported.
    - Mobility should be accompanied if possible by return grants for scholars from CEEC;
    - The long-term human scientific capacity needs of in academia and society should be determined.
7. Improving the research infrastructures should be supported, by using structural funds and co-operative funding with industry.
    - Besides large research facilities, interregional sharing of medium research facilities is to be developed and encouraged;
    - Research infrastructures should be combined with education and innovation.
8. Activities of ALLEA as a whole together with ESF initiatives to incorporate smaller research groups into European research structures is to be welcomed.

The biggest and the most difficult challenge which the smaller countries face in S&T is finding a balance between their needs and constraints in human capital and funding.

OVERVIEW ON THE ACTIVITIES OF THE WG

1. Background

Science and technology (S&T) are of vital importance to every country, large or small. "The inherent function of the scientific endeavour is to carry out a comprehensive and through enquiry into nature and society leading to new knowledge. This new knowledge provides educational, cultural and intellectual enrichment and leads to technological advances and economic benefits. Promoting fundamental and problem-oriented research is essential for achieving endogenous development and progress. Government, through national science policies and in acting as catalysts to facilitate interaction and communication between stakeholders, should give recognition to the key role of scientific research in the acquisition of knowledge, in the training of scientists and in the education of the public." (WCS Declaration, Budapest, 1999).

ALLEA has set up a Working Group "National strategies of research in smaller European countries" within the framework of ALLEA's principal goals:

- to develop views on issues that concern the development of science and scholarship;
- to give advice and make recommendations to governments, the European Community and national, international and supranational organisations.

The conceptual statement of this WG is the following:
"The European Union has clearly stressed the importance of science and technology policy and emphasised it in the Framework Programmes. The main aim is to put S&T into the service of the community of Europe. In addition, national problems of ensuring intellectual power and establishing national priorities are crucial issues. The Western European countries have a long experience in crafting national S&T strategies, and now the Central and Eastern European countries face similar problems, made even more complicated because of transformation processes still underway. The main aim of this Project is to describe models and strategies to facilitate the formation of national strategies, especially for small countries engaged in the process of moving towards the status of Member States of the EU. Despite the differences among the countries, many issues, such as the effectiveness of research structures, competitiveness of the grant market, training of a new generation, financing structures, impact on society, and others have common features. The existence of a well-defined S&T strategy and its recognition by the governments and parliaments makes a basis for normal development. The targets of such strategies will be politicians and the community as a whole. At the moment there is no other European scientific body working in this direction and the framework of ALLEA is excellent to deal with such a project: to interweave national strategies into a unifying pattern of Europe" (from the Proposal for the ALLEA Project).

Smallness of a country is not defined by a single criterion. The decisive factors could be population, area, natural sources, general wealth, and so on. But regardless of size, it is clear historically that knowledge is one of the most important factors in development. In the contemporary fast changing world, knowledge has indeed a decisive role. That is why small countries must pay attention to research and education. However, it is more difficult in smaller countries to find answers to perennial questions, such as "Why conduct research? How much research can a country afford? To what extent should the research be controlled?" Clearly, smallness means that changes can be introduced more easily. Yet, to directly mimic the funding percentages and structures of larger, successful countries, would be unlikely to produce the same outcomes because small countries lack the same critical mass and scale. The many constraints – limited manpower, limited funding, difficulties of setting priorities, a small base for direct innovation, and so on, require careful consideration of strategies and programmes. For small countries, striking a balance between broad research-based university education across disciplines and necessary support for a few established fields of research is even more difficult. Today, there are new opportunities to ask how these constraints are influenced by the opportunities provided by globalisation, information technology and international co-operation. Strategically capitalizing on national and international strength and international opportunities in an optimal way, should make it possible to enrich both – the national identities of smaller countries – and the larger community as a whole.

In 2000, the Commission of the European Communities has launched the document "Towards a European research area" and defined the main ideas of organisation of research in Europe. The following excerpts from this document characterise this view:

> "However, the principal reference framework for research activities in Europe is national. Funding of the various initiatives of European Community or intergovernmental scientific and technological co-operation does not exceed 17% of the total public expenditure on European research."
>
> "... the European research effort as it stands today is no more than the simple addition of the efforts of the 15 Member States and the Union. This fragmentation, isolation and compartmentalisation of national research efforts and systems and the disparity of regulatory and administrative systems only serve to compound the impact of lower global investment in knowledge."
>
> "It cannot be said that there is today a European policy on research. National research policies and Union policy overlap without forming a coherent whole. If more progress is to be made a broader approach is needed than the one adopted to date. The forthcoming enlargement of the Union will only increase this need. It opens the prospect of a Europe 25 or 30 countries which will not be able to operate with the methods used so far."

Given this, a vital question arises: how to progress towards a better organisation of research in Europe as a whole? "The idea is to create a European research area." It is clear that all the national strategies of research play an important role on the European stage. Only by strengthening the research potential at a national level can the goals of a European research area be realised to their full potential. The ALLEA initiative is well-timed and the studies of the WG will be interwoven into the united pattern for the benefit of both – national and European communities.

2. Activities of the WG

The WG was proposed by the Estonian, Latvian and Lithuanian Academies of Sciences at the meeting of the Steering Committee in Madrid (Nov, 1998). The Steering Committee has accepted the proposal and at its next meeting in Helsinki (May, 1999) has fixed the following WG:

1. Dr. *M. Bullock* (secretary) – Estonia
2. Prof. *R. Bansevicius* – Lithuania

3. Prof. *J. Ekmanis* – Latvia
4. Prof. *J. Engelbrecht* (chairman) – Estonia
5. Prof. *P. Kauranen* – Finland
6. Dr. *L. Pivec* – Czech Republic
7. Prof. *Y. Quéré* – France
8. Prof. *B. Rihová* – Czech Republic
9. Prof. *J. Slezak* – Slovak Republic
10. Prof. *G.Tichy* – Austria

Later (Jan, 2000) the following names were proposed by the Steering Committee to be added:

11. Prof. *F.R. Dias Agudo* (Portugal)
12. Prof. *F. Hegarty* (Ireland)

Later, Dr. *E. Kraemer* has replaced his colleagues from the Czech Republic and Prof. *A.Kralj* from Slovenia and Dr. *M.Bric* from Ireland have joined the WG.

So the WG represents 11 European countries.

Immediately after the Madrid meeting, an international conference "Science and Society: Charting the Future" was organised by the Estonian Academy of Sciences (Dec, 1998). The primary goal of the conference was to gather experts from Estonia and abroad to address a very concrete question: how can a small country, with limited human and financial resources, best develop and use its own scientific and technical potential in the service of its society? The representatives of 11 countries took part in this conference. The conference abstracts were later also distributed to the members of the Steering Committee.

In real terms, the WG started its formal activities in May, 1999. The draft plan of activities with a brief Science Policy Overview was circulated among the WG members. The plan was approved and as a first goal, a questionnaire to sister academies was formulated. This questionnaire took its final form at the World Conference on Science (Budapest, June-July, 1999).

During the World Conference on Science, a Meeting of Ministers and Senior Officials Responsible for Science Policies in Central and Eastern European Countries was organised. The Chairman of the WG (J. Engelbrecht) reported not only on science policy in Estonia but stressed the ALLEA role and the activities of the corresponding WG. This information was met with great interest by UNESCO representatives (co-ordinator of this meeting Dr. S. Anguelov). As a result, an official report of this meeting to UNESCO describes the role of ALLEA and includes a proposal to organise a follow-up meeting at UNESCO 30th Session of the General Conference (Paris, Oct-Nov, 1999).

After the Budapest meeting, the WG circulated a Questionnaire to gather current information on science policies in various countries. It was also distributed to all the members of the meeting mentioned above.

On Nov 6, 1999, the special meeting "European Partnership in Science" took place in Paris within the framework of the UNESCO 30th Session of the General Conference (undertitled "Meeting of Ministers & Senior Experts in Science Policies in the Framework of the Follow-up to the World Conference on Science and to the Ministerial Meeting of Central and Eastern European Countries, Budapest, 1999). Among the participants were 23 delegations from CEEC, 4 – from EU Member-States, and the representatives of ESF, DG-XII, Euroscience, ICSU, UNESCO. The chairman of the WG (J.Engelbrecht) presented the talk: "National Strategies for Research in Small European Countries: Preliminary Report of an ALLEA Working Group."

In March 2000, the WG has submitted a preliminary report to the ALLEA General Assembly (Prague, March 30 – April 1, 2000) based on the information from the Questionnaire. This report is available at http://www.akadeemia.ee/eng/Report.html. Next, the Workshop of experts from preaccession CEEC and Europolis on "European S&T policy and the EU enlargement took place in Venice, May 15 – 16, 2000, organised by UNESCO Venice Office (UVO ROSTE). Again, an overview on ALLEA WG was presented (J.Engelbrecht).

In October 2000, the ideas of the ALLEA WG were presented in the discussion at the Conference on S&T in Europe – Prospects for the 21st Century, organized by the Council of Europe, ESF, and UNESCO in Gdansk, Poland (9-11 October, 2000).

In June 2001, the 8th Baltic Conference on Intellectual Co-operation also discussed the research strategies in smaller countries (Tallinn, 15-16 June, 2001). The publication is under preparation.

In June 2001, the conference "An Enlarged Europe for Researchers" was organized by the European Commission (Brussels, 27-28 June, 2001). In his presentation, J.Engelbrecht has expressed the views of the ALLEA WG.

In September 2001, the conference "Opening up European Research to the World" was organized by the Belgian Government in the framework of the Belgian Presidency of the EU (Brussels, 17-18 September, 2001). As the moderator of the Section "Exchanges in the international scientific community", J.Engelbrecht has summed up the experience from the reports to the ALLEA WG

In October 2001, within the UNESCO 31st Session of the General Conference (Paris, Oct., 2001), a Round Table of Ministers of Science was organized on the topic "Rebuilding Scientific Co-operation in South East Europe" (Oct 24, 2001). This Round Table confirmed the results of an earlier conference on the same topic (Venice, 24-27 May, 2001) organized by the UNESCO Venice Office, Academia Europaea, and ESF. The recommendations of these meetings actually harmonize with the ideas of the ALLEA WG.

A good possibility to exchange the ideas on the future development will be at the conference "Flexible Europe – mobility as a tool for enhancing research capacity", proposed by the Estonian Ministry of Education to the European Commission to be held in Tallinn, June 2002. Further information is available from organizers.

In order to prepare the Final Report, an e-mail discussion between the WG members was initiated in August 2001. The recent ideas are all presented in the summary paper by J.Engelbrecht (see this volume).

The final Report is prepared thanks to the contributors and the other members of the WG. The support from the UNESCO Venice Office (Prof. P.Lasserre and S.Anguelov) is appreciated.

PUBLICATIONS ON THE TOPIC

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6. ALLEA WG. National Strategies of Research in Smaller European Countries. Estonian Academy of Sciences. Tallinn, Preprint, 2001.
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NATIONAL STRATEGIES OF RESEARCH IN THE EUROPEAN CONTEXT

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1. INTRODUCTION

In 1999 ALLEA (the Association of **All E**uropean **A**cademies) established a working group (WG) to analyse the research strategies in smaller European countries. This working group consists of representatives of 10 countries including as member as well as candidate countries of the EU. The main aim of studies is to describe models and research strategies to facilitate the formation of national strategies, especially for candidate countries. The broader question is, however, how to interweave national strategies into a unifying pattern of Europe. This question is extremely important (and timely) in the framework of the European Research Area [1].

ALLEA is certainly not the only actor in this fast developing and changing field. During the World Conference on Science (Budapest, 1999), the UNESCO Venice Office organised a special meeting of Ministers and senior experts in science policies from CEEC [2]. The second such a meeting was organised within the framework of the 30th General Conference of UNESCO (Paris, 1999) [3]. The WG has prepared the first report for the ALLEA General Assembly (Prague, 2000) [4]. The UNESCO Venice Office organised a workshop of experts from pre-accession CEEC and Europolis Project Group (Venice, 2000) [5]. Europolis has launched a special series of workshops on the European S&T policy [6]. It goes without saying that EC, ESF, Academia Europea, Euroscience a.o. have reflected many facets of national strategies of member and candidate countries in their various documents.

The list of national strategies is given in [4] as well as case studies from Austria, Finland, Czech Republic, and Estonia. The Report [5] includes case studies from Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, and Romania.

This paper is prepared by the ALLEA WG aiming to summarize the findings on research strategies just during the preparation of the next Framework Programme which should serve the realisation of the European Research Area [7].

In what follows, Section 2 describes briefly the preliminary results of the WG [4], Section 3 summarizes some important EC documents, and Section 4 reflects the current situation. In Section 5, final remarks are given.

2. ON NATIONAL RESEARCH STRATEGIES AND PROBLEMS

This Section is based on findings of the WG, submitted to ALLEA in 2000[4] for which the answers of a Special Questionnaire have given a rich material.

The following has been summed up:

1. The success of S&T in leading countries is based on science policy that encourages foresight programmes, encouragement of fluid boundaries between academia and industry, and encouragement of international co-operation. Governmental programs that encourage such activities indirectly (through the establishment of co-operation mechanisms and incentives) and directly (through investment in centres and parks and through funding of international ventures) should be scrutinized. A typical research strategy involves the following keywords: governmental aims and initiatives, research for prosperity and welfare, quality is to be promoted and rewarded, international research, co-operation, education and research, freedom and responsibility in research, structures and systems, funding targets and monitoring, evaluation. For details see Research Strategies of different countries. The role of the Government as an investor, a catalyst, and a regulator should be clearly defined.
2. Well-organised administration of S&T required setting targets and priorities, establishing mechanisms for strategic allocation of funds, establishing evaluation procedures, and engaging in long-range planning.
3. Flexible funding with multiple sources (governmental, private, third sector) must be encouraged to meet the needs of society, guarantee stability of research, and foster innovation going. Presently, international funding of S&T in small countries is relatively small, as is funding from non-public funds. Mechanisms for increasing these need to be explored.
4. Governmental initiative in setting up long-term targets (both aims and funding), creating special funds for targeted research, looking for tax incentives and levies on certain branches of industry, etc. considerably improves the outcome of S&T (cf. Norway, Sweden).
5. High-quality research is a result of long-term continuous evaluation exercises and critical (peer)-review of all results and applications; (cf. experience in Sweden, Finland, the Netherlands, Estonia). A national evaluation system works successfully in many countries and needs to be encouraged.
6. The weak points of many smaller countries, especially of those in the transition stage are – the existence of old-fashioned science structures, rigid funding schemes, weak administration, shortage of qualified (young) scientific workforce. These can be ameliorated through a strategic system of priority setting and regional and international co-operation.
7. High-quality research merits special additional support and is characterised by intensive international co-operation (cf. Finland). There is a desire in many countries to create Centres of Excellence in Research.
8. National Programmes of Research help to stress some fields and in many cases also to overcome shortages of funding.
9. S&T is not a static situation but a process that needs special attention to young researchers: graduate schools, PhD scholarships, mobility, post-doc positions, etc.
10. In many CEE countries the scientific infrastructure, including equipment is in a poor state. Special programmes, if any, could help to improve the situation (cf. Portugal).
11. Technological innovation is directed mostly to the existing traditional technologies and not to prospective areas. Investments are small, especially in the CEE countries, the role of foreign investors is small.

12. Success of S&T is based on the trust between the actors: academia-government-industry.
13. There are several specific initiatives worth to be stressed:
    - funds for realisation of government priorities (Norway) or for innovation (Finland, Ireland);
    - governmental activities for considering tax incentives (Norway, Ireland);
    - S&T levy on certain industries (Norway);
    - technology assessment by special boards or institutes (Norway, Austria, Hungary, Slovakia, Czech Republic);
    - centres of excellence in research (Finland, Sweden, Austria, Israel);
    - national initiatives/programmes (Portugal);
    - incentives for young scientists (Sweden, Finland, Austria, Slovakia, Estonia, Ireland);
    - programmes for material infrastructure (Portugal, Israel, Sweden);
    - funding provided for public awareness (Ireland).

What ALLEA WG has found out and disseminated among the ALLEA members is actually the best practice. As to the analysed research strategies, then the international co-operation is stressed in all the documents, as well as the national interests. The role of the EU Framework Programmes is usually clearly indicated. It is obvious for member countries but also the candidate countries have stated the strong support to the EU activities. On the other hand, one can find also strong statements of national interest in humanities and social sciences. Some examples are the following:

- Hungarian culture in European integration and other international processes;
- preservation of cultural heritage (Spain);
- Letonics (Latvia);
- research into development of the Dutch language and culture;

  etc.

Actually these activities enrich Europe in general.

3. TOWARDS EUROPEAN RESEARCH POLICY

The research Directorate-General of the European Commission has launched (January, 2000) the communication "Towards a European research area" [1]. Said Philippe Busquin: "... (the communication) is meant to contribute to the better overall framework conditions for research in Europe," and adds: "... it will rather be the result of a process to which all the relevant actors will have to contribute." The communication has been adopted in March 2000 during the Portugal presidency of the EU. The first step implementing European Research Area (ERA) is the proposal for the 6th Framework Programme (2002 – 2006) [7].

It states clearly three objectives:

1) To integrate European research;
2) To structure the European Research Area;
3) To strengthen the basis of the European Research Area.

There is no need to analyse all the initiatives and instruments proposed in these two basic documents [1, 7]. The WG of ALLEA has taken the viewpoint “from parts to a whole”, i.e. how the research strategies of smaller countries could reflect the national interests and how they could be cast into a general framework [4]. It is clear that today the European pattern is still fragmented and the “top-down” and “bottom-up” initiatives serve usually different interests only with certain overlapping activities. This is not surprising, because research activities in Europe are basically national. Only about 17% of the total public expenditure on European research is by joint efforts and only about one third of that (i.e. 5,4%) is through the EU [1]. The ERA communication defines many aspects of future EU activities, among them clearly directed towards coherence are:

- more coherent implementation of national and European research activities;
- greater European cohesion in research based ... on the role of the regions in the European research efforts;
- bringing together the scientific communities, companies and researchers of Western and Eastern Europe.

The last concerns, in other words, improving the contacts between member and candidate countries. The OST analysis says [6]: “Closing this gap is a major challenge for Europe.” Clearly, the proposal for the 6th FP [7] serves the idea contributing to the full realization of ERA. It stresses stronger connection with national initiatives and the genuine partnership between the EU and its member countries.

4. CURRENT THOUGHTS

Creating a whole from the parts brings up several problems as the case studies show [3,4]. There are many ideas shared by all the actors: quality of research should be promoted, co-operation, networking and mobility are important, governmental funds and/or special incentives should be created for priorities, there should be mechanisms for disseminating knowledge to public, research ethics is important, etc. These ideas are all stressed to be important in the European scale [1]. Nevertheless, not all goes smoothly, especially in the candidate countries. There are at least two possibilities for interest clashes: between large and small countries, and between member and candidate countries. In addition, one could also indicate some basic dilemmas [8, p.142]:

- equality versus efficiency;
- individual freedom versus collective order;
- spiritual versus material values;
- short- versus long-term thinking.

Indeed, if these dilemmas could be considered basic, then the situation in smaller countries is spiced with many constraints. It is quite common to indicate the constraints like insufficient funding, limited human resources, structural weakness, etc. What is however clear, if a country realises the importance of science and technology for creating the future welfare and formulates clear and successive research strategy, then the situation can be changed. A good example is the case of Finland – ideas of creating research strategy in the beginning of 1980´s has given their fruits now. Finland is far ahead of many countries with her research capacity, funding and results [9]. Examples of Ireland, Austria and Portugal are also worth of being stressed. In the candidate countries, the situation is certainly much more diverse, the main indicator of R&D intensity (GERD/GDP) is much below the EU average [1]. As far as the GDP in candidate countries is also much less than the EU average, the situation is even worse than the R&D intensity level shows. Although much spoken, not all the candidate countries have adopted the national research strategies. The situation is well characterized like “too many reforms and ambitions for too little money” [8, p.137].

On the other hand, there is a remarkable scientific potential in small countries which, especially in the CEEC is not properly mapped. The analysis of the European Commission concerning CEEC [10] relies on data up to 1998 and much has been changed within last three year. Nevertheless, together with the European Commission analysis of the S&T indicators (also up to 1998) in the member countries [11], the basis is fixed. Now the situation is changing fast with new EU initiatives and the question of national, regional, and European interests is more than ever a hot problem. This is why the ERA actions in mapping of European centres of excellence and benchmarking are of utmost importance. It means actually finding the strengths and then concentrating upon them. This is an inevitably action also in smaller countries and the prerequisite for co-operation. Dwight Eisenhower is believed to say: “Weakness cannot co-operate with anything. Only strength can co-operate.” However, there is also another side of the coin. A small country with a small number of native speakers should educate young people and in order to do so, should develop undergraduate and graduate studies. For them, research is the basic condition and so the small countries, especially those in the transition stage, cannot stick to the hard selection (only the best are kept) only. That makes often the situation very complicated and demanding.

A question formulated by Europolis Project “Scenarios for the Evolution of the European Science and Technology Policy” [5, p.20] reflects the real situation between a whole and its parts: “When it comes to co-ordination, will exist a convergence of national policies? Or would the EU move towards far greater community responsibilities with noncomitantly more diverging remaining national or even regional policies within Europe?” Today there is no answer to these questions. The ERA stresses more co-ordinated implementation of national and European research programmes. However, the 6th FP at the present stage will support the participation of the EU in national research programmes under Article 169 of the Maastricht Treaty. It means that the candidate countries are excluded although the pay the contribution to the FP. This condition will create further stresses which are actually not needed at all. One should stress the Meeting of personal representatives of research ministers from candidate countries (25.10.2000) where within the context of human resources in ERA. “ ... it was pointed out that candidate countries were excluded from some schemes, as they were not treated as “less favoured regions.” This should be “repaired in FP 6”. However, as said above, the situation seems to be same. Technically many incentives of the ERA and 6th FP serve all the countries regardless of their size, like mobility, electronic networks, intellectual property rights, research infrastructures, role of women in research, etc. What is extremely important for smaller, especially candidate countries, is the development of relations between science and society. The activities for bringing research closer to society and strengthening the science/society dialogue are usually a part of national strategies of research. Supported by the EU, the benefit will be much more visible. Clear indication in the 6th FP [7] to support the networking of European research and innovation policies is a good sign for finding the answer to the Europolis question (see above). Nevertheless, one should ask – is all that enough and even more provocatively – do we know what we want?

5. FINAL REMARKS

Small countries feel more deeply the need for sustainable development of research. To find balance between the natural wish to expand research, the constraints due to limited funding and human resources, and the needs of the society and state is not easy. That also means to establish balance between hard (only the best) and soft (everybody has some chance) selection of priorities and funding principles. From the ALLEA analysis it is recommended [5]:

- not only increasing the funding of R&D in general but channelling it to the most prospective areas;
- not only introducing incentives for encouraging innovation per se but creating foresight programmes and formulating a National Development Plan;
- not only introducing incentives for stimulation young people in S&T but estimating the long-term needs of manpower in academia and society;
- not only stimulating peer-reviewed research but creating the centres of excellence in research and supporting the formation of such international clusters;
- not only improving research infrastructures but combining them with education and innovation.

Academies can rely upon the intellectual potential of their members and long traditions. Obviously the role of academies and in this context also ALLEA is to use their capacity for:

- ensuring the quality of research;
- networking and co-operating;
- indicating the needs of the society;
- fostering new fields of research;
- helping the dialogue between science and society.

Actually two last roles mean fostering the scientific knowledge (by the definition of Academies), and the social knowledge (by the mission of Academies): first by keeping the gates open to unexpected and second by fighting the public disillusionment. This is important on both the national and international levels.

When trying to characterise the European situation, then briefly it can be done following P.Papon [12]: "The diversity of national and European scientific institutions is both a strength and a weakness. That diversity, rooted in the history and culture of each country, is an asset which makes it possible to implement widely differing modes of operation and management in the research field, geared to multiple needs, and which should pave the way for innovations in researcher training programmes. Nevertheless, the network of research infrastructures which Europe has succeeded in forming is a great asset which furthermore contributes to its scientific importance... Another weak point of Europe is the lack of "cohesion" between national efforts, resulting in a very strong imbalance in the scientific and technological development of European countries." Clearly, Europe needs a proactive policy aimed at greater overall cohesion in science and technology [12]. The similar idea was emphasised in the discussion of the J.M. Gago´s speech at the ESF session [13]; i.e. one should not aim at "a very detailed coherent European science policy but rather some general guidelines " [13, p.13]. The next question arises immediately – what should be backbones of joint efforts? If we come to funding then the research councils under the umbrella of ESF control about 50% of European public money [14]. This is much more than at the disposal of EU. Consequently, ESF activities serve the European community as a real unifying force. The EUROCORES (European Co-operative Research), for example, could be an effective tool for bringing national programmes together. The EU support to EUROCORES could be even more effective than other EU programmes. Next, networking of centres of excellence, both real and virtual, is another effective tool. Clearly this network will increase cohesion between member states but may serve another important aim in Europe – to upgrade research facilities in CEE countries [15]. The recent action of the EC identifying more than 30 centres of excellence in the CEE countries is the first step in this direction. Certainly, beside the network of centres of excellence, a strong computer network and e-libraries should also be supported. This all could strengthen the European Research Area not by general policy but by flexible contacts.

The ideas of the European Research Area have activated many institutions. High-level conferences have been organized, activities of the 6^{th} FP have been drafted (and criticized). In the general European context, the unifying role of the ESF is more and more visible. ALLEA's response to the 6^{th} FP should be stressed, also from the viewpoint of smaller countries [16] – "ALLEA warns against criteria and procedures unduly disadvantaging smaller research groups".

The keyword are similar in many documents: mobility, centres of excellence, networking, large facilities, infrastructure, etc. Indeed, the importance of those keywords and actions behind them is hard to deny. However, there is a feeling that the instruments are not sufficient to carry out all the good ideas. Certainly there are excellent examples, like Marie Curie Fellowships, the idea of introducing return grants for young researchers from less developed countries, the recent idea to organize mobility centres in several European member and candidate countries. Surely, the situation should be enhanced.

The countries face different problems due to different historical, economical, cultural and geographical background. In addition, there is a competition in science together with team work. The networking and mobility gives strong support to co-operation but countries are interested in high-level research from a different viewpoint:

- to support industry and society needs;
- to support high-level education.

That means a certain overall balance is needed but the individual actors have again different aims. A researcher seeks usually an interesting problem supported by a good infrastructure and a good team, in mature years he/she seeks for a tenure position. A state policy and high officials seek for strong labs, universities and innovation structures for a given country. Such a situation is typical, especially in smaller countries and the tensions from this polarity hinder the way to the unified European Science Policy. It means that a realistic way to move forward is to understand and accept such different views and shape the political documents not violating the trends but supporting them so that in the long run the coherence of all activities may become stronger and stronger.

Summing up, it is not surprising that the national strategies of research adopted by the Governments and/or Parliaments do not reflect the ideas of the ERA. For example, the Finnish current "development plan of education and research" covers 1999 – 2004, adopted clearly before launching the ERA. In the Finnish last review [9], it is clearly stated:" One of the most important objectives in the development of the science system in the latter half of the 1990´s was to promote international research co-operation. Key areas in this development effort included research co-operation in the European Union as well as with national science institutions in

Europe" [9, p.22]. Usually, the adopted strategies indicate the same need to find synergies with the activities of the FPs, ESF a.o.

It seems that beside networking the idea to formulate integrated science policy in some fields of research that are of common interest will need full attention. However, these actions should be prepared by all the countries and be based on consensus and mutual trust. Is there enough political will for that?

We live in a fascinating time. Nobody will make Europe a better place than Europeans themselves. Being aware of many unsolved problems as in various member and candidate countries as well as in Europe generally, scientists have social responsibility to foresee the changes.

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BIG SCIENCE FOR SMALL COUNTRIES - WHAT ARE THE ISSUES AND WHAT ARE THE PRIORITIES?

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Should federal funding give priority to fostering a strong and broad undergraduate background in all disciplines, or to establishing excellent post-graduate training in a few selected fields? Should priority be given to substantial funding for few established research projects with strong application potential or to many smaller projects across disciplines? Should researchers be encouraged to collaborate cross-nationally or should they be encouraged to strengthen national programs? Should the state commit funds to encouraging business applications and technology transfer? Should funds be committed on a sole criterion of scientific excellence or should other criteria such as national need, potential payoff or future teaching niches be considered as well? Such are the questions that small countries must address.

Although ensuring a healthy science and technology enterprise is important to all countries, big and small, the challenges of fostering training, research, and national development are especially acute in small countries where financial and human resources directly affect the scale of science initiatives. The purpose of this brief contribution is to outline some of these challenges, and to suggest some issues that must be addressed.

WHY DO SCIENCE? In a provocative summary paper, Ben Martin ("The changing social contract for science and the evolution of the university", *in press*. In Geuna, A., Salter, A., and Steinmueller, W.E. *Science and Innovation: Rethinking and Rationales for Funding and Governance*.) outlines a shift in what he calls the 'social contract' governing science. In the last half of the 20th Century, science activities were based, at least implicitly on the simple, linear model of science/innovation typified by Vannevar Bush's writings: basic research leads to applied research, technology development, and improvements in our lives, however through an unpredictable time course. This view gave autonomy to institutions and scientists in allocation of resources and priorities, and provided a rationale for heavy government investment in science.

More recently, according to Martin, there has been a shift back to a model in which governments require a more explicit research agenda focused on serving societal goals. There are two reasons for this shift - both relevant to the issues facing smaller countries. The first is that science has become more of an immediate route to achieving a competitive advantage and has become more market driven - because its role in the new knowledge society is more obvious and direct, and because scientific and technological literacy and skills have become crucial to continued growth. The second is that research and development activities now cost a lot more than they used to, and a more mission-oriented approach offers a means of accountability for the use of public funds, and provides a framework for leveraging and combining resources. It is governments (or more concretely, the public and policy makers) who define what this mission might be.

WHAT ARE THE ISSUES? Global trends of rapidly developing new technology, internationalization and integration across borders, and demands for increasingly technological sophistication and rapid innovation present a complex set of needs. For small countries it is important to strike an appropriate balance to allow science and technology activities to address both local and global development.

HOW DOES THIS AFFECT SMALL COUNTRIES?
Although not even large and wealthy countries can afford to support all possible science studies and disciplines, and must thus set policies and priorities, these tasks are even more crucial for small countries. The largest challenge is of course one of scale. A small country is less likely to be able to support both large research enterprises that require extensive interdisciplinary networks or expensive infrastructure, or to contribute a large share to such joint ventures. A small country is also unlikely to have the requisite expertise to be able to provide comprehensive high-level science training or research across all disciplines and sub-disciplines. The policy issues are then how to ensure that the science that ***is*** pursued and the training that ***is*** available best serve both societal and scientific needs.

Because of the constraints inherent in limited material and human resources, leveraging resources, exchanging expertise, and avoiding overlap and duplication are especially important considerations.

1. TRAINING: There are a number of parallel goals that a country must address centering on the breadth and structure of its science education and training at the post secondary level.

- What is the appropriate balance among breadth (broad comprehensive training so that students are prepared to enter any science field) and depth (comprehensive post-graduate training leading to high levels of expertise). For example, what proportion of resources should be allocated to ensuring that students can receive high quality, research-based training at the undergraduate level across all science fields, and what proportion should be allocated to building up graduate training or providing funds for graduate training abroad?
- What is the importance of having all levels of training available “in country”? Given limited human resources (e.g., trained researcher scientists) it may not be possible for students to receive training in specialty or cutting edge research fields at home. What programs are effective in ensuring that students who travel abroad for training and research will return to teach and work at home?
- What are the benefits and risks of leveraging resources and creating 'virtual universities' and fostering academic exchange?
- How can future leaders be identified and nurtured?

2. RESEARCH: research activities serve a number of purposes, including advancing scientific knowledge, promoting application and innovation, and aiding technological, economic and societal development

- What mechanisms best promote quality research and application (university based, institute based, topical, project-based centers); What is the appropriate balance among “big science” (science activities requiring multiple parallel activities or expensive infrastructure) and “normal science” activities?

- How can researchers participate in “big science” projects - exchange; niche development; data analysis from shared large-scale data bases
- What is the appropriate balance in providing research and development incentives to business/industry as both the producers and consumers of scientific knowledge?
- How can participation in larger-scale collaborations or scientific “virtual” communities be fostered? Is this an appropriate model both for fostering scientific progress and covering national science needs?

3. MODELS FOR FACILITATING RESEARCH/ TRAINING/ APPLICATION:

- What models of academic / research / innovation interactions have proven most productive?
- Centers of excellence: does this resource-intensive investment yield high quality research output? What mechanisms will promote a sufficiently large critical mass to facilitate research-based application and innovation?
- Research-intensive vs. integrated with training: what are the relative merits of promoting research-intensive organizations versus integrating research and training activities?
- How can knowledge exchange and researcher mobility across national borders and between universities and industry/government be encouraged?

4. GUIDING CRITERIA: in any funding policy initiative it is important to consider the criteria that will guide decisions about how and to whom resources will be allocated. There are a number of criteria including:

- Fostering excellence through peer review and accountability.
- Addressing national needs (for application to current challenges; for innovation and technology transfer; for capacity building).
- Feasibility: of knowledge production; application and dissemination.

For small countries to participate on a global level in the production and dissemination of scientific knowledge and development, it is important not only to promote the production of excellent science and scientists, but also to put in place mechanisms to ensure integration into world science – through exchange, publication and the efficient use of resources. For example, the development of mechanisms to leverage data collection efforts across researchers to create shared access to data bases or to create shared access to expensive research tools or equipment can allow data analysis, theory development, or technology transfer at a level not possible in a single-country activity.

Overcoming limitations in human resources requires developing mechanisms to promote mobility in training and research and application activities across national borders and between university, research and applied settings. Many of these mechanisms are described in the papers in this collection (centers of excellence; research ‘parks’, industry-based R&D; regional and inter-national collaborations) and these mechanisms need to be evaluated for productivity and effectiveness. Promoting the healthy development of science in smaller countries also requires discussion of mobility issues – not just of students and scientists, but also of knowledge and resources. Although creating shared access presents significant challenges in balancing national proprietary requirements and scientific development, promotion of such activities will benefit science and will foster the creation of a truly global world science.

TECHNOLOGY POLICY IN AUSTRIA

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The current fashion tells us that we are living in a knowledge-based society, economically condensed in the New Economy of dot.coms and gentech firms. Knowledge as input is considered more important to production than capital or labour, and the wealth of a nation is said to depend on its research quota. The OECD and EU are pressing countries to effect attempts to stimulate the New Economy as the only way to support growth and reduce unemployment. Austria appears as an interesting example of trend-refuting backwardness with at least temporary success. Austria is dominated by traditional industries and appears frugal when it comes to R&D expenditure but, nevertheless, enjoys low unemployment, at least average growth, a steep increase in productivity, and a fast growing EU-market share. This gives rise to several questions of potential interest to other countries: Whether a high R&D-quota is indeed the dominating indicator for prosperity-generating innovations, whether the Old Economy is indeed synonymous with low-tech, and New Economy, contrariwise, with high-tech, and whether technology policy should be restricted to direct promotion of high-tech and New-Economy industries.

AUSTRIA'S OLD STRUCTURES/HIGH-PERFORMANCE PARADOX AND TWO DIFFERENT STYLES OF TECHNOLOGY POLICY

A brief glimpse at the European Innovation Scoreboard [Kommission 2000, 37], deve-loped by the European Commission to encourage innovation mindedness among member countries, finds Austria on the backbench: A lone second rating in SME in-house innovation, a few medium ratings for the share of S&T graduates, government R&D expenditures, SME co-operation in innovation and innovation intensity, but disconcertingly low ratings for business R&D, tertiary grade workforce, number of patents, share of new-to-market products, ICT or high-tech. Yet, productivity in manufacturing (hours) increased faster in Austria than in any other European country in the last two decades, except Ireland in the eighties, and by over 60 percent faster than in the U.S. – despite its much discussed New Economy-driven, long upswing.[1] Several factors may explain this Austrian paradox.

As a first point, one must raise the question to what extent the Community Innovation Survey (CIS), an important source for the Innovation Scoreboard, is really a good basis for INTERNATIONAL comparisons. It appears that it has not yet been possible to compel participating countries to use identical definitions, so that large discrepancies prevail between the countries which are hard to explain.[2] But even if all these differences were real, aggregate data would still be misleading: Some industries are innovation intensive, others not; in some industries innovations are

[1] Production/working hour in manufacturing:

	Austria	EU	USA
1980/90	4.8 %	2.9 %	3.0 %
1990/98	5.2 %	3.6 %	3.0 %

[2] E.g. innovations per firm, or education of the work force. The level of tertiary graduates in Austria, for example, is underestimated as Technische Mittelschulen are counted as secondary only.

R&D-intensive, while in others they are primarily experience-oriented, based on trial and error. Consequently innovation intensity, patent intensity or need of research personnel differ widely among industries. Aerospace, electronics, pharmaceuticals and – at some distance – office machinery belong to the first group, while metals, machinery or paper, as well as SMEs in general, belong to the second. Austria's industry structure leans heavily toward the second group, which drives aggregate innovation data down, notwithstanding the fact, that Austria's SMEs innovate even more than their foreign competitors. SME innovations, however, tend to be rather marginal according to the usual definitions, even if economically highly successful [Tichy 1999].

A second explanation for the Austrian paradox – aside from the industry structure – is the high investment quota among Austrian firms. Especially SMEs can substitute innovation at least partially by investing in equipment that embodies the latest technological standards. Austrian firms apparently followed this strategy, investing some 10 percent more than their EU competitors and some 20 percent more than their American ones.

Two other explanations apply to EU countries in general, not only to Austria: The primary source of innovations and their character. While the source of most innovations in the U.S. is science, based on close co-operation between firms and academia, European innovations are typically user-driven [Hippel 1988; Tichy 2001a]. European innovations (and the economic development of European countries) depend more on the continued development of specific fields of long-standing knowledge [Carlsson 19979], on co-operation with customers, organisational networks, and the detection of market niches. European firms consider it more important to direct receiver competence (absorptive capacity) toward customers and suppliers rather than toward universities. Heidenreich [1999] emphasises that European competitiveness relies on experience-based knowledge stocks, incremental innovation patterns, and diversified quality production rather than on science-based innovations, so typical of the United States. External research significantly improves productivity in the U.S., but much less so in Germany [Bönte 20009], and probably in the rest of Europe as well. A number of stylised facts of European innovation systems result from the fact that the networks of European firms are with users rather than academia, and formal R&D or patents are much less important for user driven innovations than for science driven ones.

Partially as a consequence of the different sources, American innovations typically result in new products, while European innovations are embedded in other products, sometimes from completely different industries – therefore they are less visible, not only to the untrained eye but to statistics as well: Even a major innovation produced by a subcontractor is more likely to result in a highly improved end-product than in a completely new one. By way of example: Europe is the world-wide leader in 'embedded software', which rarely shows up as a product in its own right, as it is embedded in 'software packages' [BoozAllen&Hamilton 2000]. Furthermore: Austria as well as other European countries concentrates its efforts on innovations leading to top-quality in rather traditional products, to diversified quality production, as Aiginger [2000] demonstrated empirically. This strategy differs from the American New-Economy strategy, but appears to be a successful one, as the EU's positive current account demonstrates.

A closer investigation of the Delphi Report Austria (1998) has shown, that the widely accepted dichotomous view of industry, restricting innovations to high-tech industries, does not appear empirically substantiable [Tichy 2001b]. Old structures need not hinder high performance. The traditional industry classifications are, therefore, inadequate to deal with aspects of technology and innovation. The variance within the industries exceeds those between them. Technical progress, innovation and advances in productivity occur in low-tech as well as in high-tech industries, and quite often innovations in low-tech industries are of a high-tech nature. To this extent, the old structures/high-performance paradox is apparently a paradox of preoccupation, not one of reality. It is based on an innovation paradigm which may reflect U.S.-American structures, not European ones.

ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT STYLES OF TECHNOLOGY POLICY

Given the specific European innovation paradigm and the – at least temporary – success of the pronounced Austrian variant of this model, European technology policy need not slavishly adhere to the U.S. pattern. At least for a sustained period in the growth process of an economy, user-oriented development and diversified quality production appear to be an interesting alternative. This is in striking contrast to current preoccupations of the general public as well as to the policy prescriptions of the OECD, the European Commission and most governments that concentrate exclusively on high-tech and especially on the New Economy. Such a high-tech oriented policy, forces most countries to developing a completely new innovation paradigm, to build new networks, to accumulate new capabilities, to enter new and risky markets, and to radically downsize the traditional sector. For most of the countries this task will keep them busy for decades, with uncertain results. User-oriented innovation in diversified quality production builds more on already existing (European) strengths, and can be applied as an alternative or as the other route in a double-track strategy.

Having said this, one must add, however, that focusing on such an alternative policy in the long run is not without problems. Path-dependence, incremental improvement and dominating customer relations may delay adequate structural change [Christensen and Rosenbloom 1995]. The user paradox [Tichy 2001a] says that user-orientation is very successful in the short- and medium run, as it ensures applicability and diffusion of innovations. But it includes quite a tendency to prevent radical innovations and the development of really new products for the markets ten years hence. And old structures/low-performance could, indeed, result in the future. The European model may, furthermore, imply some corporate myopia. At least the Austrian Delphi exercise revealed a rather short-term horizon and rather modest pretensions of Austrian innovators in firms as well as in research institutions [Tichy 2000].

The Austrian experience, therefore, appears to demonstrate, that the user-oriented, incrementalist model of innovation fits quite well for countries still in a process of catching up in productivity and income. By using this model, countries that are catching up can enjoy a free ride on the technology of more advanced countries by imitation and by importing high-tech investment goods. In Austria, only about half of the R&D-content of output stems from own direct R&D-expenditure, and a quarter each from domestic and foreign inputs respectively [tip 1999, 54]. However, the more a country approaches the technology frontier, the more it is forced to find high-tech niches in which it can predominate; and the more it is forced to risk innovations designed for the markets of the future, which are thin today if they exist at all. In fact, Austria should have switched to a policy of enforcing more radical innovations almost a decade ago; its policy of incrementalism has lost most of its employment-generating effects, today [tip 1999, 87-92]. The Austrian process of reorientation of technology policy is slow, too slow indeed, however, it has accelerated lately. Some of the new instruments and the experience gained in this process of re-orientation may be of more general interest.

IMPORTANT ELEMENTS OF THE AUSTRIAN TECHNOLOGY POLICY

Up into the nineties, Austrian technology policy supported the prevailing innovation system. This didn't mean, however, foregoing any attempts to support new technologies. Two independent government funds, based on the peer-review system, financed scientific and applied research[3] on a bottom-up basis, and the government set top-down initiatives in specific areas as e.g. materials technology or computer-aided design and production. Funds were limited, however, and the competence for technology policy was spread across three state departments. In the nineties, it became increasingly clear that Austria had succeeded in catching up with other high-income countries, so that it had to turn from a recipient of foreign technology to a developer of country-specific technologies. A new technology policy was needed. Several preliminary projects were commissioned by the government, such as the tip-research programme 1996-99 (**T**echnology-**I**nformation-**P**olicy Advice) or a draft of a Technology Concept for the Central Government (1996); the government elaborated Strategic Guidelines and Action Lines of Technology- and Innovation Policy (1997). A foresight exercise into fields of potential Austrian technology dominance, the Delphi Report Austria, was commissioned in 1996 and published in 1998. Technology policy was widely discussed in these years, and – as in all discussions among involved intellectuals – views differed widely. Nevertheless, several needs of utmost importance emerged:

- considerably increasing the R&D-quota (1 ½ percent at that time),
- accomplishing a university reform heading towards an acceleration of studies, evaluation-based concentration of research as well as a reduction of the number of institutes, and an increase in the mobility of the staff,
- developing an application-oriented degree of tertiary education below the degree of 'Magister',
- distinctly focussing technology policy,
- concentrating government support on more radical innovations in a limited number of technology fields,
- enforcing co-operation of academia and firms, and
- setting initiatives to increase the number of high-tech start-ups.

Several larger or smaller steps implementing such reforms were taken since, in several stages, with various degrees of success. UNIVERSITY REFORM as the most complicated of these, proceeds rather slowly. Universities are more autonomous nowadays, but their structure hasn't changed much to date. The number of institutes is as large as before, their size undercritical, and university research remains scattered. The attempts to reduce life-time tenures for "Assistenten" (a position below the level of professors) and to increase mobility apparently have come to deadlock.

By way of contrast, the attempts to establish a degree of tertiary education below 'Magister' have been very successful. Since 1997 some 20 FACHHOCHSCHULEN have been founded, providing a job-oriented four-year education and an improved basis for regional innovation. Two major innovations should be stressed in this respect:

[3] FWF – Fonds zur Förderung der Wissenschaftlichen Forschung (Science Fund) and FFF – Forschungsförderungfonds der gewerblichen Wirtschaft (Technology Fund).

The foundation of Fachhochschulen is based on calls for tender with a competitive selection process based on evaluation and the demand for skills. The specialties of the Fachhochschulen existing today comprise engineering, electronics, telecommunication, software as well as business. The second innovation is the implementation of public-private partnership: Only half of the finance necessary for Fachhochschulen is provided by the central government; business partners must contribute at least one fifth.

Likewise, there is considerable success to report in the realm of CONCENTRATING TECHNOLOGY PROMOTION on a limited number of promising fields. The two autonomous fun-ding bodies that promote science and technology got more money and added special top-down programmes on top of their bottom-up oriented support structures. The Science Fund (FWF) now supports 17 "Spezialforschungsbereiche"[4] to create local centres of excellence, 13 interdisciplinary "Forschungsschwerpunkte"[5] and 2 "Wissenschaftskollegs"[6] supporting younger top-quality scientists. The Technology Fund (FFF) offers interindustry support programmes. The Ministry of Technology implemented several "Impulse programmes" based on the results of the Delphi foresight exercise. Programmes on innovations in sustainable mobility, sustainable energy and environment technologies have been supported, and an investment in a climate-wind-channel for rail vehicles (Rail Tec) has been made.

The two most innovative instruments, however, are the Kplus-initiative and the government's programme on biomedicine. They both rely on the strategy of building strengths and existing capabilities rather than trying to implement those that work for others.

COMPETENCE CENTRES ACCORDING TO THE KPLUS-PROGRAMME are a specific Austrian invention meant to promote pre-competitive research co-operation between academia and corporations. Kplus research centres can be founded co-operatively by at least five firms and more than one research institution for a period of seven years, and are aimed at high-level pre-competitive research in a specific field. At least 40 percent of the necessary funds must be provided by the participating firms, 35 percent are contributed by central government, while the rest can be supported by other public funds, if available. Each Kplus centre is operated as a company (GmbH). The programme is administered by a government-owned company TiG – Technologie Impulse Gesellschaft, responsible for calls for tender and evaluation, based on a peer review system. Up to now, two calls for tender found 12 competence centres eligible, comprising some 170 firms and 40 research institutes. Public support of about ATS 1.2b (EUR 87m) is provided for the first four years. After that period the centres are evaluated for their further eligibility for the following three years of promotion. The research specialties of the Kplus-centres comprise advanced computer vision, application-oriented software, virtual reality and visualisation, advanced telecommunication technology, sensor-actuator systems, applied electrochemistry, bio-molecular therapeutics, and light-metals high-performance materials. A third call for tender has now started which will create additional centres starting in 2002.

As the participating firms have to finance at least 40 percent of the expenditures, the R&D-programmes of the Kplus-companies build on the firms' existing capabilities and intend to develop them by confronting them with the latest research. They are basically application-oriented even if the development of the application will need quite some time. The second innovative approach of the Austrian technology policy,

4 designed to last for 10 years

5 duration 5 years

6 duration unlimited, but to be evaluated every 3 years

the BIO-CENTRE, is more science-based and more of a New-Economy-oriented approach. As early as in the seventies, Vienna had some very good academic bio-tech research, albeit small in numbers, which co-operated with industry, and a few research institutes in the bio-tech industry. In the eighties, technology policy decided to concentrate these activities locally to generate critical mass and create synergies. A university-industry joint venture was supported which proved highly successful, and did in fact provide the nucleus for further activities. As a result of a study on potential high-tech clusters in Austria, commissioned by the Ministry of Technology, a biotech cluster emerged, bearing a fair promise of success. Thus, the activities were pushed ahead. Since 1993, there has been a focus, a “Forschungsschwerpunkt”, on biomedical technology. Meanwhile other research institutes have settled or plan to settle in the neighbourhood of the Viennese bio-tech centre.

By international standards, Austria is a latecomer in bio-tech. However, its example demonstrates, that even in unfavourable conditions – a small country and latecomer with a reserved public stance toward gene technology – can achieve remarkable results. They were achieved as a result of the combination of several instruments: Building on strengths, even if they are limited, financial support not just for one research institute, one firm or one activity but for a cluster, local concentration of efforts, provision of adequate real estate, as well as co-operation between all levels of government, university and industry.

A third Austrian technology initiative should not go unmentioned. While the Bio-Tech centre is important for its contribution toward the formation of high-tech clusters in Austria, and the Kplus program in introducing high-tech into the ‘Old economy’ and improving the co-operation of academia and firms in long-term projects, the so-called AUTO-CLUSTER is more oriented toward organisational innovations. In Austria, especially in the Styrian region around Graz, several subcontractors to the car industry were located, some in fact highly innovative firms, developing top-level Diesel-engines or advanced four-wheel traction systems, others rather low-tech ones, supplying simple mechanical devices or leather for car seats. In the nineties, attempts were made by the Styrian government to foster co-operation among these firms and to form a cluster. The government promoted up-grading activities, pressed for co-operation, supported start-ups and foreign direct investment, and founded a company that took on the management of all these tasks. These attempts were highly successful. The cluster now comprises more than a hundred companies. The region has come to be one of the world’s most productive centres for assembling special models in small series, as the firms have learned to produce several, distinct types of cars on one production line. Accordingly, the car-cluster teaches at least two important lessons: Firstly, that even in the so-called Old economy, innovations – some of them high-tech indeed – can be highly successful; secondly, that organisational innovations can be at least as successful as technical ones.

Following the 1999 elections, a new government was formed in 2000 which plans to place even more emphasis on technology policy. It pooled all technology matters in the Ministry of Transport, Innovation and Technology, which brought a clear advantage in general, but at the cost of a separation of technology policy from science policy and universities, now administered by the Ministry of Education, Science and the Arts. Plans are to raise the R&D-quota from the prevailing 1 ¾ percent to 2 percent in 2003 and 2 ½ percent in 2005. A newly founded Council for Science and Technology has been formed to advise the Government. Few definite results, however, can be reported up to now. In any case, the two technology funds and some research institutes have already received additional funds, partly at the expense of general purpose funds for universities, while tax treatment of research expenditure in business firms has improved.

FOUR CONCLUSIONS

At least four lessons can be learned from the Austrian experience: Firstly, that recent emphasis on high-tech in general and New Economy in particular, is overdrawn. A small country in a medium state of development may in some cases get more value for its promotion money by promoting high-tech innovations and high-tech improvements in those (traditional) industries in which it has already accumulated distinct capabilities of its own. The Styrian car cluster is a good example for a highly successful approach of this type. Secondly: investment in high-tech equipment can be a temporary alternative for small countries in a medium state of development. The more, however, such a country succeeds in catching up and the closer it comes to the level of its most advanced competitors, the more it has to search for country-specific high-tech market niches. Thirdly: organisational innovations, specific institutions, organising technological co-operation or the formation of clusters, are at least as important as purely technical innovations. Fourthly: the Austrian experience suggests that government, academia and business should co-operate not only in R&D but earlier on, in designing the institutions that support innovations. Such a partnership approach was typical for almost all Austrian projects, from Fachhochschulen and Kplus-centres to cluster management.

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RESEARCH AND DEVELOPMENT POLICY IN THE CZECH REPUBLIC

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In the research and development (hereinafter called R&D) policy the principles of the current government program in the field of R&D are formulated. The Czech Republic by its R&D policy calls upon the traditions of developed countries in which science has always been an established cultural value belonging to the basic spiritual needs of a human being. R&D satisfies, on one side, the longing of a man for knowledge and widens his own spiritual horizons, and is, on the other side, a precondition for the production of material assets and permanent development of the society.

The Czech Republic declares by means of its R&D policy the determination to contribute to the internationally created and shared wealth of new scientific knowledge, particularly in connection with its effort to enter the European Union. The main goal of R&D policy is to improve efficiency of the R&D in the Czech Republic as well as to ensure a flexible and sustainable economic development.

GOALS AND PRIORITIES

Higher efficiency in R&D cannot be achieved without a certain concentration of human and material resources. The rate of the R&D success depends on its utilization on the international market of products, technologies, and services. Publishing and evaluating results on the international level plays also an important role.

It is useful to differentiate between the systematic priorities which should improve flexibility and efficiency of the R&D system as a whole and the thematic priorities.

SYSTEMATIC PRIORITIES

At the present time the most important systematic priorities are:

- Basic Research
- Applied Research
- Human Resources
- Regional Aspects
- International Cooperation

BASIC RESEARCH

The dominant sources of finance remain the public means which will be used so that a base for the domestic applied research and development could be enhanced and internationally recognised results could be achieved. A free and creative environment in the basic research is essential for the preparation of new specialists. It will be supported by fostering closer interconnection of R&D with the education process at universities.

APPLIED RESEARCH

The public means, both target-oriented and institutional, are and will remain only an additional source of financing for the applied research. With the exception of agriculture and forestry research the main financial source must be provided by the business sector. In general the financial support from the state budget must not fall outside the scope allowed by the EU regulations.

HUMAN RESOURCES

The R&D system cannot be successful without the continuous renewal and support of motivation, abilities, and capacities of its participants. The problem of continuously increasing average age of the R&D workers in the Czech Republic requires a complex solution which will include: increasing interest of youth in R&D and in the activities in this area – the interest must be developed from the earliest courses of the school attendance; improving economic situation of young R&D workers; widening possibilities of the career for young talented students and scientists; supporting mobility of young scientists (both domestic and international); facilitating creation of research teams around perspective young scientists.

REGIONAL ASPECTS

A substantial part of the R&D capacities in the Czech Republic is currently concentrated around several cities and traditional universities. The government long-term policy will support a wider spread of R&D activities in various regions. This is particularly important in regions which are less developed, suffer from a high rate of unemployment or in which a complex restructuring of industry is under way.

INTERNATIONAL COOPERATION

The globalization of the world economy and information flows increases the need of involvement of the Czech Republic in the international R&D cooperation. The reasons for the international R&D cooperation include economic benefits for the society and for the R&D system (connecting to various networks, a better training opportunities for young researchers, etc.) as well as the general increase in efficiency of basic research. In documents issued by the European Union the term “added value” is used in this context. The purely political justification of the international cooperation is not recommended. It is necessary to evaluate all cases of the international cooperation organized on the governmental level as well as participations in non-governmental organizations with respect to this criterion of the “added value”.

In order to take advantage of these chances, the information and consulting services for the subjects interested in the participation in the 6th Framework Program of the EU will be offered on a larger scale. For example, the possibility of establishing a Czech Liaison Office at the EU will be examined. Such an office could be financed and used only by the Czech Republic or it could be formed in cooperation with some other countries involved in the 6th Framework Program.

THEMATIC PRIORITIES

Thematic priorities will concentrate on both oriented and non-oriented research. In case of the non-oriented research in the Czech Republic, the selection of the themes, processes and methodologies will be left on the initiative of the research workers in the field. In the wide area of the oriented research priorities will be established on the basis of perspective needs of citizens, the society and the Czech economy. The Czech government will play an important role in this process.

NON-ORIENTED RESEARCH

In this part of the basic research the government will not directly influence the selection of the research themes and processes in any way. The research in this area must respect only the internationally recognized moral and ethic principles. However scientific institutions and organizations involved in the non-oriented research receiving funds from the state budget will have to observe following guidelines:

a) The results of research will be regularly evaluated by independent commissions
b) Successful solutions of research problems require a certain concentration of resources (human, technological and financial) and therefore disposable resources should not be diluted in too many projects
c) Even this part of the research should help to increase the prestige of the Czech science resulting from its contribution to the general world knowledge. It should take into account also perspective requirements of connected R&D areas.

ORIENTED RESEARCH

The selection of priorities of the oriented research will be based on:

a) The anticipated needs of the Czech economy which the oriented research will satisfy and for which a public support could be obtained
b) The requirements of further sustainable development of human and economic potential in the Czech Republic
c) Potential R&D capacities in the Czech Republic. The priorities will be formulated in a structured and coordinated national R&D program and in research plans. Experience shows that it is beneficial to divide the programs into the thematic and horizontal ones. . The thematic and horizontal programs create the oriented research structure.

The selection of priorities in the oriented research is a time–consuming complex process which will be divided in several stages :

STAGE I

The R&D policy will establish a limited number of priorities based on expected needs of the society which will form the basic structure of the national R&D program structured in thematic and horizontal programs.

STAGE II

The formulation of criteria for evaluation and decision making process enabling the selection of suitable partial programs (directions) and suitable projects for attaining the partial program goals. It is highly desirable to ensure that these criteria remain unchanged from the start of the program preparation until its final realisation. The same criteria should be also used for evaluating research plans of organisations.

STAGE III

The selection of partial programs (directions) which could help to fulfil the priorities established in the Stage I on condition that criteria formulated in the Stage II are fully respected.

THE STRATEGY AND TOOLS

Even the best vision of the R&D remains a mere declaration unless it is complemented by the strategy of its implementation and by realisation tools. These tools are the necessary part of the policy, especially when the significant changes of the legislative and financial rules are taking place. The tools are more important for the countries in the transition period than for developed countries operating within relatively stabilised systems and uninterrupted traditions.

The academic community and the non-governmental sector favour the approach based on initiatives of individuals and working teams which consistently observe clearly defined rules. When solving problems and during the decision making process they prefer steps taken at the lowest possible level. The opposite way of solving problems i.e. down to bottom approach will be used by the government in the R&D policy in situations when the market signals are too weak or when these signals do not correspond with interests of the society as a whole. It is usually applied to legislative processes, to the optimised utilisation of public funds. and to explaining how the public funds were used.

The goals of the R&D policy are based on the government program promise of gradual increasing the state support of the R&D up to 0,7% of GDP by the year 2002 according to the following schedule:

a) to 0,6% of GDP in 2000;
b) to 0,65% of GDP in 2001;
c) to 0,7% of GDP in 2002

After 2002 the development of the government expenditure on R&D will depend on topical priorities and possibilities given by the economic situation of the country. However the long-term goal of the government R&D policy remains the same i.e. to increase the state R&D support to the average level existing in the EU countries.

The state R&D support will be focused mainly on long term activities in the basic research, on activities associated with a higher level of risk in the applied research and on the activities whose results will be utilized mostly by small and medium enterprises without any R&D capacities of their own.

DIRECT STATE SUPPORT OF R&D

The public and non-governmental R&D means must be interrelated. The reason is not only in saving taxpayers´ money, but also in the need for keeping an optimal relation between macroeconomic intentions of the state and the microeconomic approach of enterprises. From the viewpoint of financing three categories of research activities are recognised: basic research, applied research and pre-competitive development. The maximum proportions of the state means used in financing R&D in the above mentioned categories are determined by the following rules :

Basic research	up to 100%	of the costs
Applied research	up to 50%	of the costs
Development	up to 25%	of the costs

In common projects that include private enterprises and organisations supported from public funds, the maximum allowed contribution from public funds could be increased in following cases by:

a) 10% when the contribution is used by a small or medium enterprises
b) 10% when the contribution is used in a region with an extraordinary high unemployment rate
c) 10% when the contribution is used in the economic sector supported by the government
d) 15% when the contribution is used in projects of the EU Framework Programs

However certain general limits have to be preserved. The accumulated contribution from public funds in any case must not exceed :

a) 75% of the costs in case of applied research;
b) 50% of the costs in case of development.

Rules on limited scale of the state co-financing of R&D are continuously examined, adjusted and checked. In the case of applied research the strategy of synergetic effects will be applied especially in situations when a higher support from public funds results in increase of support from private funds ("matching funds"). The government is also prepared to support projects of industrial development by "soft" loans with preferential or even zero interest.

INDIRECT STATE SUPPORT OF R&D

The indirect R&D support serves mostly as a signal of a pro-innovation climate in the country and as a stimulation of private business activities.

The indirect support is applied especially in countries with high level of taxation as a form of compensation. It has, in a standard legal environment, a number of practical advantages (starting with low administrative costs and ending with a small probability of misconduct). The indirect state support of R&D is still rather an exception in the Czech Republic.

Most of the tools of the indirect R&D support have been examined during the preparations of the R&D policy : deductions of gifts supporting R&D in income tax calculations, a faster depreciation of technical equipment used for R&D, tax allowances for small and medium-sized enterprises, tax stimulation of the venture capital for R&D, customs free imports of R&D, a possibility of creating a reserve for R&D, etc. The individual tools of the indirect R&D support will be evaluated with the aim to increase the number of cases when the minimal scale of taxation and other allowances could be applied in the Czech Republic. The long-term strategy remains the stimulation of the non-governmental sector and increase of its competitiveness.

MORALS AND ETHICS

All might not be solved by laws and by an organizational structures. It is true especially for R&D with many dynamic changes and questions, which it asks itself and the society. The importance of the moral and ethic dimensions of exploration and the utilization of R&D results have been undervalued for a long time and their cultivation must not be put aside. There are problems resulting from the fast development of areas which have not been yet legally anchored and which must find its substance in moral and ethic codices.

The R&D representatives will prepare an ethical codex for scientists. The codex will deal with problems of falsification, "making-up" results, copying, misuse of R&D results, refusal to publish the results of R&D funded from public resources, etc. The R&D representatives will also prepare an ethical codex for R&D organisations dealing with problems which might not be completely resolved by legislation.

Ethical principles based on international declarations and agreements will be soon established in the healthcare and also in other areas and sectors working with biological materials (agriculture, environment, etc.). Activities of commission members, who make decisions on allocating public funds, will be regularly examined. Clearly defined regulations for personal nominations into these commissions will be made public.

The R&D of products and processes banned by international agreements or conventions must not be financed from public funds. Research activities which are incompatible with the ethical and moral principles recognised by the world scientific community will receive absolutely no support from the state.

SCIENCE AND TECHNOLOGY IN ESTONIA

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1. INTRODUCTION

In the beginning of the 21st century, Estonia is still shaping its higher education and S&T structures. The last decade since reinstating the independence has been full of changes and general restructuring was directed to four key problems: restructuring decision-making, reorganising research establishments, reorganising funding and reforming higher education. This process has been characterised, for example by Engelbrecht [1,2] and Dagyte et al [3]. In this paper, the attention is focused on the current situation and further activities.

2. CURRENT SITUATION

Estonia is a small country with its 1.4 million inhabitants and two main cities – Tallinn and Tartu where the higher education and research potential is concentrated. At present (anno 2001), there is a rather well functioning system of research in Estonia but the drawbacks are also clearly evident.

From the positive side, there is a clear and flexible legislative basis for the S&T system and education. Next, funding is based thoroughly on the peer-reviews. The long-term (project-based) funding is decided by the Ministry of Education on the recommendation of the Science Competence Council (SCC). The same Council gives also recommendations for funding the infrastructure. Both basic and applied research are funded. Short-term grants are allocated by the Estonian Science Foundation (ESF). This is the system based on the bottom-up initiative. Fixed funding ratios between the disciplines is set up only for grant-funding. Roughly speaking, the budgets of SCC and ESF are weighed as 2.2:1 in 2001. In addition, infrastructure is about 30% from the project-based funding.

Innovation was funded up to 2000 by the Estonian Innovation Fund. The matching principle with industry was used but technically this Fund has limited sources only. In 2000, Ministry of Economic Affairs has restructured this Fund creating the Technology Agency. At present, the budget of the Agency depends on the results of privatisation.

Estonian experience includes the following:

- there are incentives for supporting young people in research; these include special research fund for the PhD research, post-doc positions, special PhD and MSc research stipends from grants;
- there are examples attracting private sources to improve infrastructure: a new laboratory for tumor research was built for the Estonian Biocentre by funds of Citrina Foundation (UK); a new building for pre-clinical education and research was built for Tartu University on the loan by the World Bank;

- the first step is taken towards improving the infrastructure for biological collections;
- the Centres of Competence were built up at Tartu University and Tallinn Technical University supported by the PHARE Programme;
- peer-review is the basis for all funding decisions.

The drawbacks in the R&D in Estonia are also evident. The first is the low impact of the research for innovation caused by the general economical situation. This is also partly the reason for the low indicators of funding R&D, because the interest from the industry is low. The second is the general situation of the infrastructure and the third – limited manpower. The threat for the brain drain is not so evident but it exists.

Evaluators have sometimes mentioned the inbalance of public investments towards basic research and those fields of science that are not directly connected to industries. However, such a funding has kept high standards of research and education which is a "must" for a small country. It is clear that this inbalance in funding should be changed not by changing the ratios between the fields but by increasing funding towards innovation and development, i.e. creating conditions for implementing the results of the research.

The present situation is summarized by a report of the Science and Development Council [4].

3. CURRENT ACTIVITIES

Investments into research and technological development are cornerstones for the progress in every country. In the fast-changing world a social agreement is needed between the whole society and its actors in order to maximize the efforts towards knowledge-based society. This is done by agreeing on S&T strategies and there are many examples of countries, big or small, who have successfully implemented their strategies. In Estonia, the first project of the Science Strategy (Knowledge-based Estonia) has elaborated by the Estonian Academy of Sciences in 1998 [5] and the Innovation Strategy – by the Estonian Innovation Fund in 1997. Presently (in 2001), the Government has set up two main tasks:

(i) to reorganize the existing Science and Development Council (the main advisory body at the Government) into a more effective institution;

(ii) to agree on the general S&T strategy reflecting the current trends and possibilities in Estonia and in Europe towards the knowledge-based society.

Although the new strategy document is being compiled by the Ministry of Education and the Ministry for Economic Affairs, the experience from first projects is embedded into them. The main ideas of this document are summarized below.

First, the strategic aims are obviously similar in many countries:

- increase the quality of life and social security;
- renew the knowledge base and enhance the education on all levels including life-long learning;
- increase the economic growth by supporting the capacity of enterprises to implement the results of R&D;
- support co-operation on national and international levels.

In a small country like Estonia there are many constraints and also needs. It is difficult to list them in a successive order of importance, but some of them are as follows:

- limited qualified manpower;
- limited funding;
- a need to keep the national educational system functioning;
- a need to foster research for the national identity (language, history, nature, etc.);
- a need to foster basic research in order to guarantee the quality of higher education and give possibilities to talented people in these fields to work home;
- a need to foster applied research and development to get more innovative ideas for the industry.

Clearly, the needs should be balanced and it is possible only by making choices. The instruments for that are the quality requirements, estimations of possible outcomes and concerted actions. The last instrument seems to be the most important because in a small country the averaging effects are weak. In addition to that the transition period still influences the development by its pragmatic short-sighted views and the cash-in-cash-out principle often prevails.

The present Government intends to define clearly its role in S&T, stressing the roles of an investor, a catalyst, and a regulator. As an investor, the Government plans to invest more into the education and S&T, including basic and applied research and supporting the infrastructure. As a catalyst, the Government works out strategic plans for education, supports collaboration between the various actors, and creates conditions (including taxation) for the private sector to use new knowledge for innovation. As a regulator, the Government creates and supports a system for applied research and innovation, creates and funds national programmes for supporting the key areas of R&D.

What are the central points of the Estonian S&T strategy?

First, almost in all countries excluding some superpowers, there is a need to concentrate efforts in S&T in order to reach critical mass and to enhance competitiveness. The key areas should be chosen for which the activities will be concentrated. These key areas depend first of all on the existing scientific potential, possible applications and economic conditions. Defining them, one follows the line of pushing. The other side is related to the existing economical factors (especially industrial) that needs R&D to be involved – that is the pulling effect. In a small country like Estonia both these conditions are extremely important spiced still with the effects of transition period. So the S&T strategy formulates three key areas:

- technologies for the information society;
- biomedicine with applications;
- materials technology.

As for the existing industrial needs, there is the governmental support, too. A special point for all the smaller countries is to balance the research for future with the research for the needs of the country. It is stressed that the research directed to Estonian language, society and environment should be guaranteed. In other words, these areas mean the Estonian cultural and natural heritage.

These three key areas are in the full concordance with the European Science policy and the preliminary project of the 6 Framework Programme. This is certainly not the only decisive factor. The most important reasons to choose these three areas are the existing scientific potential, signs of the growing enterprise sector using this potential and the wide area of possible further applications. This is actually an example showing that even under the political pressure which ended only a decade ago, the science in Estonia was prepared for further activities. So, we may now list up many possible applications and activities within these three key areas:

> Technologies for information society include data security and coding, communications, hardware devices and components, software architecture systems and techniques, e-learning and e-banking, technologies for multilinguistic processing, etc. The private sector in these areas is growing, the government uses widely electronic data bases, the membership of Internet connections is high.
>
> Biomedicine with applications is based on strong clinical medicine school from one side and fast developing molecular biology from another side. The research results permit to foresee new diagnostic methods, new methods of medical treatment, decreasing the illness risks, etc. Research in these fields is closely related to gene technology. A special Genome Project has been started to map the genetic information of all the population (following the example of Iceland). There are several successful small enterprises and qualified manpower.
>
> Materials technology is based on research in solid state physics, chemical physics, chemistry, etc. which all have been strong but academic during many decades. These results are now ripe for practical applications – nano-materials, laser technologies, optical memories, optoelectronics, methods and devices for material research, etc. The society should use these in industrial technology, communications, electronical industry, energy systems, medicine, etc. Again, the existing small enterprises need a push. The potential of researchers and engineers in this field is high.

Second, there should be instruments not only for realizing the ideas in key areas but also in general terms. The S&T strategy shows how to strengthen the infrastructure for applied research and innovation. The Technology Agency (ESTAG) is the main governmental institution for that. The conditions for creating Technology Centres at two leading universities should bring researchers closer to industrial interests. In order to support high-level research, the Estonian network of Centres of Excellence in Research will be created. That means also direct mapping of excellence and linking them into the European network. Two centres (one in physics, another in biotechnology) already exist under the EU scheme, the seed money for the others in 2001 is already allotted by the government. The support for young researchers is regulated, although the system has still the bottlenecks due to small budget. The S&T strategy stresses the needs to popularize the research results and to dignify knowledge in general. Much more attention should be devoted to Programmes, especially in order to foster the key areas. National Programmes on Health, and Estonian Language and Culture already exist, although with limited support.

Third, the targets should be clearly determined. So the Government foresees the growth of R&D expenditures for 2002 up to 0.8% (instead of preliminary wish 1.2%!) and for 2006 up to 1.5% from the GDP. The role of the private sector should be increasing, the ratio 100:12 (i.e. government : private sector) in R&D funding in 2000 should be 100:60 already in 2004. This is not an easy task. The debates on the budget 2002 show that meeting these targets is not easy.

On Dec 6, 2001, the Estonian Parliament (Riigikogu) has approved the Science and Development Strategy 2002 – 2006 "Knowledge-based Estonia". The first 5 national Centres of Excellence in Research in addition to existing 2 Centres (see above) have been nominated in December 2001 together with 7 potential Centres. The nomination is based on the international evaluation with the help from the Academy of Finland. The Estonian Ministry of Economic Affairs has started a project for supporting science-industry R&D co-operation through establishment of joint technology-oriented structural initiatives. For that, an international working group has been established together the national steering committee.

4. ESTONIA IN THE EUROPEAN CONTEXT

Estonia is now participating in the Fifth Framework Programme and feels already strong positive impact of that in shaping priorities locally. The recent EU document "Towards a European research area" has been discussed widely. The common agenda for large facilities is approved as well as the need for central computer data banks like those for genomics and proteomics, in astrophysics, etc. There are several examples of cooperation with CERN, Maxlab in Lund, Coriolis Laboratory in Grenoble, etc. Another aspect is that Estonia, as a small country, can see a possible impact in promoting virtual centres of excellence. A common European education and research network should be considered as one of the top priorities. Estonia welcomes also the coordinated implementation of national and European research programmes. Here, the opening of national programmes would be an important step forward. As to the instruments of indirect support to research, then first the development of the common education and research network and second, the protection of intellectual property are of importance. The mobility of researchers is always a two-way road. However, the existing gap in income means the utilization of the principle of free movement is hindered as far as west-to-east movement is concerned. The European research area means a real cooperation that needs a reinforced role for regions. The suggestion to combine Structural Funds with R&D funds provided by FP is welcome and Estonia waits also the Commission to be more pro-active in encouraging governments to channelling such funds for the R&D capacity building. For the successful integration of the Estonian scientific community into the common European research area we stress improving standards of research, intellectual property rights and open debates on ethical issues of research. In particular, attention should be paid to enhancing European patent system (introducing the grace period, for example), common policies related to stem cell research, patenting of gene sequences and genomes, etc.

Estonia is (since 2000) also a full member of the European Science Foundation. Being actively involved in various inter-governmental and non-governmental institutions, Estonian scientific community has its representatives and votes in shaping the further European R&D policy. For example, Estonia has its representatives in all the ESF Standing Committees and is already involved in the ESF activities. The Estonian Contact Point for the 5th FP takes care of EU projects and applications. Estonia is also engaged in the IPTS/JRC Project on EU-Enlargement, Building Linkages on Prospective Activities. Chairing the ALLEA WG on National Strategies of Research in Smaller European Countries, the links have been established between Academies. In this context, cooperation with UNESCO Venice Office has been extremely useful.

International cooperation has supported good results in astrophysics, solid state physics, molecular biology, marine sciences, etc.

5. FINAL REMARKS

Estonia has clearly understood its strengths and weaknesses. The Government has set up the target to improve considerably the situation of S&T as a main tool for general welfare. Quality of research, active co-operation within Europe, and innovation are the keywords for the future. Typically for a small country, there is a need for basic research for preserving and enhancing education and general competence. Once the Science and Development Strategy has been approved, the hope for future trends is high.

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OVERVIEW ON RESEARCH AND DEVELOPMENT IN FINLAND

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Finland, a country of about 5 million inhabitants, underwent an exceptionally rapid transition from a largely rural to an advanced industrial country after World War II. The success of this transition can be partly ascribed to a long-term input of resources into education, research and industrial development.

An active science policy was initiated in Finland at around the end of the 1960's. Advancement of economic growth and improving the quality of life were expressed as aims of science policy. "Catching up" with the other industrialized western countries in R&D intensity was also often mentioned as a goal. Later on, special emphasis was put on promoting research in high-tech fields, and a "knowledge based society" became a frequently cited goal of science policy. In 1969 the volume of research and development (R&D) in Finland was about 0,8 % of the GDP. Until 1999 this figure about quadrupled to 3,1 % [1,3].

FUNDING OF SCIENCE

In 1999 the total expenditure on R&D in Finland was 3,87 billion EUR (3,1 % of the GDP). The breakdown according to performer was (data of Statistics Finland [1]):

Private sector	2640	million EUR		68 %
University sector	760	"	*)	20 %
Gvt. Research Institutes	470	"		12 %

*) Based on the assumption that 40 % of univer-sity expenditure is used for research

Of the R&D funding, about 66 % came from the private sector and 31 % from the public (Government) sector. In addition, about 3 % of the funding came from foreign sources.

From 1991 to 1999 the average increase of R&D funding was about 9 % per year (in real terms). The growth was particularly rapid in the private sector, especially in the electro-technical industry. In 1999 the Nokia Company performed about one third of the industrial R&D in Finland.

A special budgetary package of 250 million EUR for scientific research was granted in 1997 to 1999 [3]. A little more than half of these funds were earmarked for technological research and about 20 % both for the universities and the Academy of Finland. The package was financed by using income from the sale of Government owned stock.

DECISION MAKING ON NATIONAL SCIENCE POLICY

The Parliament adopts the State budget, allocating funds in broad categories to the University system, the Academy of Finland (Research Councils), Research Institutes, and other specified activities.

The Science and Technology Policy Council is an advisory body for the Government and a high level meeting ground for representatives of government, academia and industry. Its members are Ministers and representatives of the academic community and industry. The Council does not make policy or funding decisions, but its opinions carry a great weight. The Council also prepares and adopts Science Policy Statements, the latest in January 2000 [2].

A proposal for a new Law on funding of the Universities was discussed by the Parliament at the end of the year 2000, but due to differences of opinion concerning its financial consequences, the proposal was withdrawn by the Government. A new proposal is under preparation.

The Ministry of Education decides on the distribution of funds between the universities. The funds are allocated as “lump sums”, but the Ministry may give instructions or restrictions on their use.

THE ACADEMY OF FINLAND AND TEKES

The Academy of Finland is the main organ for basic science administration and funding in Finland (it is not an academy in the traditional sense, but the Research Council system of Finland). The Research Councils allocate funding on the basis of applications and peer review. A maximum of 25 per cent of the research funds are reserved to predetermined research programmes, the rest is “free” research money. The Research Councils are also funding postgraduate studies, postdoctoral research and international scientific collaboration, as well as full time research positions for junior and senior researchers and research professors. The research is mostly performed at universities and research institutes.

The total budget of the Academy of Finland for the year 1999 was 166 million EUR. This is about 13,5 % of the total Government research appropriations. More than 80 per cent of these funds are granted to research at the universities.

The Academy of Finland is publishing every three years a report on the state of Finnish science. This report contains a comprehensive report on Finnish science policy, organization and funding. The latest report is from the year 2000 [3].

The main funding organ for applied technological research in Finland is the National Technology Agency (TEKES), which is operating under the Ministry of Commerce and Industry. The total budget of TEKES in 1999 was 412 mill. EUR, of which about 34 % was granted to universities and research institutes, the rest mainly to private enterprises. Companies applying for support from TEKES are also required to pledge funds of their own.

Neither the Academy of Finland or TEKES have research institutes of their own, all their R&D funds are channelled to R&D activities in universities, research institutes and companies. Although the Academy and TEKES are operating under different ministries, there is plenty of cooperation between them, they are e.g. funding many joint research projects.

PRIORITIES AND STRATEGIES IN SCIENCE POLICY

Annual budget negotiations are arranged between the appropriate Ministry on one side and the universities, the Academy of Finland, TEKES and the research institutes on the other side. In these negotiations priorities are discussed, goals are set and the resources needed to attain these goals are agreed upon. Strategies for reaching the goals are the responsibility of the research units and researchers.

The Ministry of Education is preparing, in collaboration with the universities, every four years a Plan of Development for the university system. The Plan is finally adopted by the Government. It contains proposals for overall new developments in universities, but also detailed target numbers for graduates in different fields at each university, for postgraduate education, guidelines for future budgets etc. The Plan of Development also contains proposals concerning international collaboration, encouragement to sharing university resources etc.

Finland has taken part in the EU Frame Programmes since the FP2. This participation has become increasingly important, and funding of Finnish projects from FP4 was more than 200 million ECU [3]. Finland has actively participated also in FP5 and has taken a positive stand towards ERA and FP6, it is supporting a total budget of 17 billion EUR for FP6. Finland is also represented on the new European Research Advisory Board EURAB (two Members, Prof. Reijo Vihko, The Academy of Finland and Dr. Juhani Kuusi,Nokia Co.).

The long standing scientific connections to the United States are also important for Finnish science, particularly in postdoctoral research.

A “broad front” approach is generally applied to disciplinary allocations, especially in basic science, but some national priorities have been set, e.g. biotechnology and information technology. A part of public funding is directed according to the priorities set. High quality and internationalization have been adopted as overall goals for all science in Finland.

CENTERS OF EXCELLENCE AND SCIENCE PARKS

As of now, 26 Centers of Excellence in research have been nominated by the Academy of Finland for 2000-2005. These Centers are receiving earmarked funding from the Academy, which is allocating about 5 % of its budget to this purpose. The Centers are working inside universities or research institutes, and are funded on an average as follows: From the host - 34 %, Ministry of Education - 9 %, Academy of Finland - 15%, TEKES - 4 % and other external sources - 39 %. The total annual expenditure of the Centers is about 48 mill. EUR. Recently, 16 new Centers have been nominated for the years 2002-2007.

There are in Finland half a dozen science parks that are partially sponsored by the Government. The main part of the funding of the science parks comes from industry through sponsored projects.

SPECIAL AREAS OF INTEREST

THE SCIENCE INFRASTRUCTURE

During the depression years of 1991-94 the university budgets were considerably cut, and these cuts have not been completely compensated later. Problems in providing adequate scientific equipment to researchers have been common at the universities. Due to the tight budgets and the increasing number of students, most university departments have been short of operating funds. These problems have been discussed at various levels, including the Parliament, and some additional funds have already been granted.

Overhead costs of project-type research have also been frequently discussed. Some, but not all research grants include a provision for overhead. The Academy of Finland has recently adopted a system of compensation of overhead costs of its researchers working at universities or research institutes. Some private funding agencies have adopted the same practice.

The scientific libraries of Finnish universities are all facing financial problems. A large number of subscriptions of scientific journals have been canceled, and buying of text books and other scientific literature has been reduced, in some cases to a fraction of the earlier amounts. The problem has been partly alleviated by cooperation of scientific libraries and by intensifying the use of remote-loans and internet connections. The Ministry of Education is sponsoring the establishment of an electronic library system in Finland.

ENCOURAGEMENT OF TECHNOLOGICAL INNOVATION AND COOPERATION BETWEEN ACADEMIA AND INDUSTRY

The role of the National Technology Agency (TEKES) is most important. Another organ is the Finnish National Fund for Research and Development (SITRA), operating under the super-vision of the Parliament. SITRA invests capital in growing, especially high-tech companies.

The recent expansion and success of Finnish high-tech industry is at least partially a result of consequent long-term investment in research and education of technology, as well as close and successful collaboration between different R&D agencies of the country.

The connections between industry and the universities of technology have traditionally been close: There are plenty of industry-sponsored projects, a large part of the diploma-works are done in industrial companies, there is an exchange of personnel both ways (this has been promoted by establishing temporary and part-time professorships). Some companies working e.g. in electronics have organized supplementary education and postgraduate studies for their staff to ensure an adequate supply of trained persons to the company. Science Parks are also a means of promoting collaboration between academia and industry.

BALANCE IN SCIENCE TRAINING: IS SCIENCE OVER OR UNDERPOPULATED?

The unemployment rate of university graduates is very low in Finland, although everybody may not find his or her ideal employment. Up to now, there has been lack of graduates in some fields of technology, especially information technology, mainly because of the very rapid expansion of these fields. Due to the recent decline in the employment in information technology, the situation may change now, at least to some extent. In addition, a deficit of graduates also in medicine has been noted. There is some oversupply of graduates in basic fields in humanities and social sciences, but otherwise the training and demand seem to be approximately in balance.

The aim of the Ministry of Education is to increase the number of graduates and PhD's. A place in either the universities or the polytechnics should be available for 70 per cent of the age class by the year 2004.

STATUS OF WOMEN

Women are in majority on the undergraduate level at the universities in all fields except technology. The proportion of women on postgraduate and higher levels is lower, but shows an upward trend. In 1999, about 43 per cent of the new PhD's were women, and about 20 % of all professors are at present women. To attract more female students, the universities of technology have arranged supplementary courses in mathematics for those applicants, who have passed only short mathematics courses at school.

Recently, professorships in “women studies” have been established at several universities. In the University of Helsinki a special unit, the Kristiina-institute, has been founded. Of the 37 Research Professorships of the Academy of Finland, one is specifically earmarked for “women studies and gender research”.

SCIENCE EDUCATION AND TRAINING

PRE-UNIVERSITY

The lack of university applicants with an adequate background in mathematics and natural sciences has caused plenty of discussion. Special efforts have been undertaken to increase and intensify studies of mathematics and natural sciences at secondary schools.

For the same reason, the Academy of Finland is arranging for secondary school students annual competitions to promote their interest in scientific research. The winners are offered a study place at a university. Also other forms of collaboration between universities and secondary schools have been initiated, to ensure the recruitment of talented students.

UNIVERSITY

The attraction of university studies is high in Finland. About 20 000 new students were enrolled in the Finnish university system in 1999, which is about one third of the age class. The number of applications was considerably higher. During the same year 11 900 students graduated on the masters level. As a new target, the Development Plan calls for 14 000 Masters degrees to be completed annually by 2004.

There are 20 universities in Finland, and the regional coverage of Higher Education is well developed. Special problems have been a rather high drop-out rate in some fields, slow progress of studies and, as a consequence, a high graduation age (this is partly due to the high portion of students having jobs during their studies). Recently measures have been taken to accelerate the studies, e.g. a time-limit of 5,5 years has been set for obtaining public scholarships. A proposal to limit the total study time to 10 years is under consideration.

POSTGRADUATE

A career in scientific research is rather highly appreciated among Finnish university graduates, there is no lack of qualified applicants to postgraduate studies.

“Graduate Schools” for postgraduate students were initiated in 1995, and they are now operating in most fields of science. The total number of Graduate Schools is at present 97 and will be increased to 108 by 2002. The number of participating students is approximately 4000, about 2500 of whom are doing full time research. Students showing satisfactory progress can get full financial support for up to four years. The other 1500 postgraduate students are doing part-time research and working as teaching assistants or at other jobs. The Academy of Finland is supporting the Graduate Schools by providing funds for teachers, seminars, travel etc.

Until recently, postgraduate studies were largely performed by teaching assistants as a side occupation. The Graduate Schools have greatly improved the position of PhD-stu-dent. Also the possibilities of private foundations to support post-graduate studies have improved.

The number of new PhD's doubled during the nineties, and in 1999 a total of 1165 students received their PhD degree. The number of new PhD's is proposed to be increased to 1400 per year by 2004. A number of postdoctoral research positions have been established and are financed by the Academy of Finland.

There is also a well working system of continuing education in Finland.

SUMMARY

From 1969 to 1999, the Finnish R&D grew from 0,8 to 3,1 % of the GDP. In 1999 the total R&D expenditure was about 3,9 billion EUR. About 66 % of funding came from the private sector and 31 % from the Government. A “knowledge based society” has often been cited as the aim of science policy. During the 90's the growth rate of R&D in Finland was around 9 % per year. At the same time, the output of high-tech industry in Finland increased rapidly, and its export value now supersedes that of the traditional wood-based and metal industries. These achievements can at least partly be seen as a result of long-term investments in R&D.

The main organ for basic science administration and funding is the Academy of Finland. The total budget of the Academy for the year 1999 was 166 million EUR, which is about 13,5 % of the total Government research appropriations. The research is done at universities and research institutes. In addition to research projects and salaries, the Academy is also funding international scientific cooperation, Centers of Excellence, Graduate Schools etc.

The main public funding organ for applied technological research in Finland is the National Technology Agency (TEKES), which is operating under the Ministry of Commerce and Industry. The total budget of TEKES in 1999 was 412 million EUR. Of this about 34 % was granted to universities and research institutes. There is plenty of cooperation between the Academy of Finland and TEKES, e.g. a large number of jointly funded research projects.

By 2000, 26 Centers of Excellence were nominated by the Academy of Finland. The Centers are operating inside universities and research institutes, and they are financed by the host, the Academy, Ministry of Education, TEKES and other external sources. In 2002 an additional 16 Centers of Excellence will start operating.

A “broad front” approach has generally been applied in science funding, but some general national priorities have been set, e.g. biotechnology and information technology. Recently participation in EU Frame Programmes has become increasingly important for Finnish science. Finland has taken a positive stand towards ERA and is preparing for FP6.

There is a well developed and regionally extensive university system in Finland, offering a study place for about one third of the age class. There is generally an adequate supply of qualified applicants to academic careers. Because of tight budgets and increasing number of students, the universities are experiencing a

shortage of operating funds. In some fields also a high drop-out rate and slow progress of studies have been seen as problems.

The situation of post-graduate students has been greatly improved by the founding of Graduate Schools in 1995. In 1999 there were 97 Graduate Schools with about 4000 students. The academic labor market is about in balance, with some lack of graduates in information technology and medicine, and some oversupply in the humanities and social sciences.

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ON RESEARCH POLICY IN IRELAND

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Over the past five years, support for research has become a priority of public policy in Ireland. This has coincided with the country's remarkable economic success, and a realisation that further development can be sustained only if innovation, research and advances in knowledge are actively supported by the Government. The promotion of such a "knowledge-based economy" has led to new and better infrastructural and financial resources for research. It has also led to a comprehensive overhaul of research policy, involving not just the "top down" approaches of economic strategists and university presidents, but also the "bottom up" activities of individual researchers. The result is a provision of IR£1.95 billion for expenditure on research and technological development and innovation in the country's *National Development Plan, 2000–2006.*

Traditionally, advanced research in Ireland has been principally supported from the block grants that are given each year to the country's third-level institutions. These allocations fund teaching as well as research, but are distributed within each institution as it sees fit. During the 1990s, this procedure was criticised and in 1994, a specially-convened *National Education Forum* concluded that in the interests of a more coherent and dynamic policy on research, the teaching and research components of the block grant should be separated. It was also argued that this would lead to a more effective management of research on campus.

The *Report on a Comparative International Assessment of the Organization, Management and Funding of University Research in Ireland and Europe* (1996) dealt with these debates by advocating more explicit and novel approaches to research. It pointed out that there was "virtually no financial support for basic science, little post-graduate support and very inadequate funding structures". It also stressed the need for each institution to produce a research strategy. This was later adopted under the terms of the *Programme for Research in Third-Level Institutions (PRTLI)* which was launched in November 1998.

The *PRTLI* is administered by the *Higher Education Authority* and has three broad objectives: to enable third-level institutions in Ireland to realise their research capabilities; to fund researchers to develop high-quality research; and to encourage collaboration both within and between institutions. Since then, it has managed three separate calls for proposals, to which all third-level institutions are invited to apply.

Institutions are asked to make a single consolidated application to the programme. Although they may promote a number of projects, they are obliged to act within their broader and stated research policies and strategies. In itself, this is a new departure in Irish research policy. However, what makes it radical as well as new, are the incentives which the *PRTLI* also offers for inter-institutional, as well as interdisciplinary collaboration. As a result, the centres of excellence which have received funding under this programme not only reflect the scientific excellence of a given institution but also promote collaboration between institutions.

For example, the *Institute for Social Change* (University College, Dublin:UCD) which was funded in 1998, brings together academics in political science, economics and sociology from both UCD, where the institute is actually located, and Trinity College, Dublin (TCD). The *Centre for Biomedical and Engineering Science* (National University of Ireland, Galway: NUIG) received £16m. from the 1998 call and last year, the *Centre for Human Settlement and Historical Change*, also at NUIG, received funding for projects involving the departments of History, English, Languages, Archaeology, and Geography. A number of other centres of excellence which have been funded under the PRTLI involve many disciplines. They also have the capacity to associate with other third-level institutions: institutes for technology as well as universities. For example, the *Institute for Regional and Spatial Analysis*, located at the National University of Ireland, Maynooth (NUIM) received some IR £3m. in funding from the 1999 call. This project brings together researchers from the departments of Geography, Sociology, Anthropology, History and Economics in NUIM and provides links with four institutes of technology as well as with Mary Immaculate Teacher Training College, Limerick.

The establishment of such centres of research excellence is a radical departure in Irish third-level research. It will ensure that the respective host institutions will have the capacity and incentive to implement research strategies which will give them critical mass and world-class capacity in key areas of research. In 1998 and 1999, a total of over IR £220m. was made available to fund the first two calls. Half of these funds were provided by the Government, the remainder coming from the *private* resources of the institutions themselves. In December 2000, a third call was announced, with funding of at least IR £160m. coming from the provisions of the *National Development Plan*. All awards are made on a competitive, peer-reviewed basis by an international panel of experts.

The *PRTLI* scheme has revolutionised both the funding and structures of research in Ireland. However, not every researcher can be accommodated within programmes that are driven by the declared strategic priorities of an institution. With this in mind, the Irish Government commissioned another report, *The Humanities and the Social Sciences: A Case for a Research Council* (1999). This report suggested that research policy had to evolve in a balanced way and that the needs of individual researchers, as well as those of smaller and non-capital projects, had to be recognised. It led directly to the permanent establishment of both the *Irish Research Council for the Humanities and Social Sciences (IRCHSS)* in February 2000 and the *Irish Research Council for Science, Engineering and Technology (IRCSET)* in June 2001.

Of the two councils, only the *IRCHSS* has a track record to date. Since May 1998, when it was established on an interim basis, and February 2000, when it was established on a permanent basis, the *IRCHSS* has developed five different schemes. The first provides funding for *post-graduate students* who are pursuing higher degrees by research in Irish universities and is open to all citizens of the European Union (EU) who are also permanently resident within the EU. Currently, these post-graduate scholarships are valued at £10,000 a year, in addition to fees, and may be held for up to three years, depending on the seniority of the awardees. A *post-doctoral awards* scheme was introduced in 2000. These awards are open to applicants of any nationality for a period of either one or two years. They are valued at £25,000 a year and offer the recipients an opportunity to develop and enhance their research at an Irish third-level institution.

In 2001, the *IRCHSS* announced two schemes which will enable permanent academics at Irish third-level institutions to take research leave from their respective institutions. A third offers leave to complete a doctorate which has not been completed due to the pressures of teaching and/or administrative duties. Each of these awards is valued at IR £30,000 which is given to the institution of a successful candidate in order to recruit a replacement lecturer. In this way, the Council hopes that its awards to fund research leave will not disrupt the teaching mission of an applicant's department. In 2001, the Council's budget is about IR £4m. and will be increased substantially in 2002 to fund project-based and collaborative research.

The programmes of the *IRCHSS* to provide funding for individual researchers are complemented by schemes in the pure sciences that are operated by *Enterprise Ireland*. These are funded by the Department of Enterprise and Employment and include post-graduate and post-doctoral awards, the *Research Innovation Fund* and the *Basic Research Grants Scheme* which are administered by the National Research Support Fund Board (NRSFB), a sub-group of *Enterprise Ireland*. The *Research Innovation Fund* supports research ideas with commercial potential that arise from researchers within the third-level academic community. The *Basic Research Grants Scheme* funds researchers to establish new research programmes, or build on existing ones in biotechnology, biology, chemistry, earth sciences, mathematics, computer science, physics land engineering. As such, it is likely that it will have a close working relationship with the newly-established *IRCSET*. In 2001, the NRSFB approved funding for 69 projects, to a total value of IR £6.33m. 170 doctoral research scholarships were also awarded as well as 10 post-doctoral awards.

The *Health Research Board* was established in 1987 and manages similar programmes for the health sciences. In 1999, the Board's expenditure was IR £6,5m., of which almost IR £4,5m. was spent on grants for medical and health services research.

A third sub-set of research policy is managed by *Science Foundation Ireland* (SFI). Following the recommendations of the *Technology Foresight Reports* (1999), this body was established in 2000 to promote research in strategic areas relevant to Ireland's economic development that have been identified by the Government. Its first call for proposals (July/September 2000) focuses on Biotechnology, and Information and Communications Technology (ICT) and for the period 2000–2006, IR £560m. has been set aside to resource applications from scientists of proven research experience and ability in these areas. It is funded through the Department of Enterprise, Trade and Employment, under the aegis of *Forfas*, the National Policy and Advisory Body for Enterprise, Trade, Science, Technology, and Innovation.

Under the programme, researchers can apply from anywhere, provided that they locate their projects in Ireland. They are also expected to conduct their research in teams, led by a Principal Investigator. Depending on the type of research involved, these teams usually consist of 3 to 12 people, for whom SFI provides generous resources for scientific and technical support. For is part, the research team will pursue a programme of work which will advance scientific research in Biotechnology and ICT.

A final area of research is managed by older research institutes such as the *Royal Irish Academy (RIA)*. The *RIA* was established in 1785 and has a number of national committees which bring together experts in various areas of academic life. In some instances, these committees have been used as vehicles to promote research projects and international exchanges. Until five years ago, this institution was among Ireland's few national centres of excellence. In the interim however, Irish research policy has changed beyond recognition. Ireland's third-level sector has adopted a new sense of strategic planning and the Government is rewarding this. In addition to promoting the "bottom up" and "top down" schemes that have been discussed, the Government has also developed its own specific strategic projects. These include a recent decision to develop a digital village in Dublin. This has attracted a most significant anchor-tenant in Media Lab Europe (MLE). This originated at the Massachusetts Institute of Technology (MIT) and is the first such research venture MIT has undertaken outside the United States.

The combination of good planning and resources is transforming Irish research policy and in the years ahead, this will strengthen academic networks between Ireland and its international community.

THE PRESENT SITUATION OF SCIENCE IN LATVIA

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Analysis of the current situation of science in Latvia shows that Latvian scientists enter the 21st century with both achievements and severe problems. However, the latter are not so dramatic, and science in Latvia still exists. It does, despite the coercive experiment of the last years, when the lowest critical limit of financing was determined, under which some of the scientific branches are doomed to complete disappearance.

The rooms of the Latvian Academy of Sciences have heard many contradictory opinions about the situation of science in Latvia. It would be worth to mention two of them:

1. education and science are the national wealth of Latvia (Nov. 1999, Society of Latvian Intellectuals and the meeting of LAS);
2. the current science policy in Latvia cannot prevent its collapse and the ensuing rapid decline of the quality of higher education; moreover, it eliminates a real possibility for science to influence the processes of Latvia's human development and national economy (Febr. 2001, conclusion of the long-term development concept “Latvia: from vision to work”).

The truth lies usually somewhere in the middle between the extreme opinions, because the science policy on a national level has made it almost impossible for the scientists to re-orientate their research. Such a policy dramatically restricts (both in the bureaucratic and in the organisational sense) the possibilities for Latvian scientists to attract any serious foreign (mainly EU) investments.

Just to turn to the traditional national budget allocations for science. Not mentioning absolute numbers, let me use some comparisons. Recently A. Silinš, the LAS Secretary General reviewed Latvia's national budget for 2001, and noted that the budget of the LR Saeima (85 %) could be compared to science budget. It could be easily calculated, that the funds available to each member of the Saeima, consisting of 100 members, for his / her operations and an active Latvian scientist out of 2000 scientists, relate to each other as 17:1. Our officials usually tell that the only way to improve the financial position of scientists is by reducing their number. Hopefully, the number of deputies and scientists will be never made equal in Latvia.

The national budget allocations for science are earmarked for the following kinds of scientific activity:

1. PAYMENT FOR LATVIA’S PARTICIPATION IN EU 5TH FRAMEWORK PROGRAMME (5.3 % from the total budgetary funding of science). This is the only financial source with a state-guaranteed yearly increase (according to the regulations of EU, and Latvia has to observe them), and Latvian scientists consistently raise twice as much finances as is paid for the participation by the Latvian side (needless to say that the funding comes from the EU budget). In this kind of scientific activity Latvian scientists have

entered into a fierce competition with their European colleagues and the start proves to be very successful.

2. RESEARCH ORDERED BY STATE INSTITUTIONS (6.9 %). The funds are allotted to ministries for solving local scientific problems. For many years these themes were not known to our scientific community, and finally in 2000 with a financial support of the 'Soros Fund - to Latvia' institution these investigations were summarized and reviewed. It appears that this kind of research is solely funded from the state science budget and no other funds are attracted.

3. MARKET-ORIENTED RESEARCH (10 %). Its task is to stimulate small - scale science-intensive enterprises by partially co-financing particular pilot projects and by promoting the activities of technological centres and parks. Such form of financing is conducive to scientists' involvement in the technological development of Latvia, since it is associated with attraction of private capital for the needs of applied science.

4. ALLOCATIONS TO SUPPORT SCIENTIFIC ACTIVITY, which are earmarked for academic and applied research, and for the maintenance of the requisite infrastructure. For this purpose the largest portion (77.2 %) of the state science budget is directed. Although this activity can attract the least extra-budget money it is most strongly controlled by state institutions. Thus, for example, rules N 342 of 26 September, 200 of the Cabinet of Ministers of LR, transformed all scientific projects into state orders with all ensuing legal consequences. Moreover, starting from the year 2001, reports on each project are to be submitted quarterly and yearly. It seems that the Ministry of Education and Science of the LR has not realised yet that, in compliance with these CM rules, the Latvian Council of Science has already prepared the first complete set of reports on 695 projects with the total number of pages equal to 3000. Such a package will be submitted to the Ministry. And it will happen each quarter, so the Ministry will be forced to enlarge its staff. The more that basing on the above mentioned reports the Ministry will have to prepare a master report and forward it to the Ministry of Finances of the LR. Thus, we see how much trouble the scientists put to officials (though caused by the rules invented by the latter themselves). At the same time, it is well known that the state science budget, expressed as a percentage of the Gross Domestic product (GDP), is gradually decreasing. This fact always surprises our Western colleagues, including those from the EU. The only thing that we can tell them is that, if considered in absolute figures, the state science budget has slightly increased (by 7 % in 2000). The reason is that, in compliance with the agreement between LR and EU, for such a sum the payment for our participation in the EU.5 programme has to be increased. The growth of the Latvian GDP makes us happy, because we live in this country, yet it has nothing to do with positive changes in the funding of science.

It is, undoubtedly, essential to distribute the funds allocated for scientific activity among the priority scientific branches. In this sense the Latvian Council of Science has a good experience. Last summer the10-year anniversary of its work passed unnoticeably.

The LCS experts traditionally divide the Latvian science into five branches (blocks), and the governmental funds allocated for scientific activity are given to winners of the project competition and distributed among the branches as follows:

Natural science	22%
Engineering science	19%
Medicine and biology	26%
Agriculture and forest science	14%
Humanitarian and social science	19%

Obviously, it could be asked whether such a sharing is properly substantiated and whether it is correspondingly ensured by highly qualified workers.

According to the latest information which is at the LSC's disposal, in Latvia there are about 2000 actively working scientists - those who, in compliance with the LR law "On the scientific activity", carry out scientific works and who are awarded the Doctor grade in accordance with the established order. The division of these specialists in science branches is in precise correspondence with the finance shared (see Table 1).

Table 1

The distribution of research potential and state science financing in Latvia (2001)

Blocks of research branches	Active scientists, %	Financing for ensuring scientific activity, %	Financing of projects, %	Financing of joint projects %
Natural sciences	22	22	24	17
Engineering sciences	19	19	18	24
Medicine and biology	20	26	26	21
Agricultural sciences and forestry	14	14	13	18
Humanities and social sciences	25	19	19	20

The LSC carries out, on a competitive basis, financing of two kinds of projects: small-scale projects (grants), which are performed by 3-5 scientists, and large joint projects (programmes), carrying out of which consolidate several groups of scientists from various higher education establishments and scientific institutions. The tasks of these projects are different. Small projects are mainly performed at the departments and faculties of higher education establishments as an academic research, with involvement of students. The large projects are carried out, as a rule, for solving topical problems of national economy, and the state and municipal structures, as well as enterprises, are often involved in performing and financing them. However in this work, one can count only on the above- mentioned scientific potential (that is, 2000 scientists) that could be attracted to particular projects. These possibilities are demonstrated also in the distribution of financing between projects and joint projects (Table 1).

A more detailed analysis of the Latvian scientific potential proves that in the branches determined by the LSC, small working groups of scientists carry out investigations on the average for 4000 – 6000 Latvian Ls per year (see Table 2). Such level of financing, with minor deviations, is typical for all scientific branches, which means, in fact, that the funds are used only for paying the minimum salaries and the regular infrastructure expenses. This, in turn, means that it is impossible to attract governmental funds for developing science (e.g. for acquiring scientific equipment).

Such a situation has been persisting for years, and during this period of time the number of projects (grants) and the distribution of financing between the branches almost hasn't changed (see Table 3). It could seem that in Latvia the scientific potential and financing are in balance and the development of the state doesn't require to increase the number of scientists.

However, when estimating the situation with the number of scientists per 10000 residents not only in EU countries but also in the candidate-countries (including our most close rivals) it has to be concluded that in Latvia the situation is tragic (Table 4). Presently the number of scientists in Latvia per 10000 residents is on the average 1.9 times less than in Estonia, 1.3 times less than in Lithuania, 2.6 times less than in EU, and so on. It means that for the Latvian science to give an equivalent contribution to the national economy, the number of scientists should be, without delay, raised 1.5-2.5 times. It must be noted that the state budget doesn't envisage any increase of the number of doctoral students in the next two years, although in 2000 only 22 persons in Latvia received the degree of a doctor (meanwhile 200-300 such persons per year are needed).

Catastrophic deficiency of highly qualified scientists is not only hindering us in renovating the teaching staff at higher education establishments, but also makes it impossible to fulfill the scientifically-technological projects, which are urgently needed for rapid up-to-date development of the national economy (to GDP raising), and for attracting foreign investments.

Table 2

Distribution of fundamental and applied research projects among scientific branches (2001)

Branch	% from the total financing	Number of projects	Financing for 2001, Ls	Average sum for a project Ls
Informatics	5.58	46	188 524	4 098
Mechanics, mechanical engineering, energetics	7.51	62	251 499	4 056
Physics, mathematics, astronomy	13.08	89	441 996	4 966
Chemistry	10.20	65	344 540	5 301
Scientifically-technological foundation of chemistry, materials, pharmacy	4.66	33	157 436	4 771
Biology, environment science, hydro engineering, earth science	9.73	72	328 963	4 569
Molecular biology, microbiology, biotechnology, virusology	7.22	39	243 943	6 255
Medicine	10.37	100	350 488	3 505
Agricultural science	10.89	45	368 060	8 179
History (culture history incl.)	3.03	14	102 423	7 316
Linguistics, literature science, folklore study, art science	3.93	28	132 869	4 745
Philosophy, sociology, psychology, pedagogy	6.14	55	207 312	3 769
Economics, juridical science	5.85	33	197 715	5 991
Cilviculture	1.81	14	61 197	4 371
Total	100 %	695	3 376 965	4 859

Table 3

Distribution of financing of fundamental and applied research projects among scientific branches

Branch	2000.g.		2001.g.	
	Number of grants	Financing, Ls	Number of grants	Financing, Ls
Informatics	47	189 215	46	188 524
Mechanics, mechanical engineering, energetics	56	254 667	62	251 499
Physics, mathematics, astronomy	91	443 621	89	441 996
Chemistry	56	345 835	65	344 540
Scientifically-technological foundation of chemistry, materials, pharmacy	26	158 008	33	157 436
Biology, environment science, hydro engineering, earth science	72	330 166	72	328 963
Molecular biology, microbiology, biotechnology, virusology	28	244 842	39	243 943
Medicine	74	351 801	100	350 488
Agricultural science	50	369 411	45	368 060
History (culture history incl.)	9	102 788	14	102 423
Linguistics, literature science, folklore study, art science	25	133 371	28	132 869
Philosophy, sociology, psychology, pedagogy	50	208 079	55	207 312
Economics, juridical science	23	198 440	33	197 715
Civilculture	19	61 430	14	61 197
Total:	626	3 391 674	695	3 376 965
Joint projects (programmes)		1 402 585		1 417 294
Total:		4 794 259		4 794 259

Table 4

The number of scientists per 10000 residents

Latvia	1998	18.6
Estonia	1998	34.8
Lithuania	1998	24.0
Hungary	1995	26.0
Poland	1995	29.0
Denmark	1995	57.0
Finland	1995	67.0
Sweden	1995	78.0
EU	1995	49.0

Source: The yearly statistics books of Estonia, Lithuania and Latvia; OECD (1998)

CONCLUSIONS

1. The current scientific potential in Latvia is not sufficient to ensure the ever increasing demand for the quality of higher education and specialists engaged in fulfilment of appearing scientific and technological projects (international included). At present in Latvia there are about 2000 efficiently working scientists. IT IS IMPERATIVE TO WORK OUT AND REALISE A PROGRAMME FOR SCIENTIFIC AND ACADEMIC STAFF RENOVATION.

2. The state budget deficiency and lack of investments have led the infrastructure of the Latvian science to the critical point, beyond which irreversible degradation of many scientific branches as well as outflow of specialists to other countries has to be expected. Already now about 1000 scientists from Latvia are working abroad (the damage is estimated at 100 mil USD). IT IS IMPERATIVE TO WORK OUT AND REALISE THE NATIONAL CONCEPT OF HIGHER EDUCATION AND SCIENCE DEVELOPMENT.

3. The Latvian science possesses considerable experience in attracting extra-budget finances from EU and other sources, partly using financial sources of the state budget. At present, the Latvian scientists participating in EU.5 scientific programmes ensure almost twofold back-paying as compared to the participation expenses of the state; in a number of scientific institutions the taxes that have been paid exceed the financing from the state budget; in other words, many of the scientific branches could be profitable provided there existed a national strategy of innovation activities.

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NATIONAL STRATEGIES OF RESEARCH IN SMALLER EUROPEAN COUNTRIES: THE CASE OF PORTUGAL

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1. A VERY BRIEF RETROSPECTIVE

1.1. In the sixties, when R & D activities were stimulated by UNESCO and OECD, the latter organization launched the so called pilot-teams project to help its less developed members to study the needs of scientific and technological research in relation to economic development. Portugal embarked on the project with Greece, Ireland, Italy, Spain and Turkey. All the national scientific and technological system was analysed and, with the collaboration of the Portuguese Institute of Statistics, many data were obtained that showed the bad situation of the country (Table 1).

1.2. In the twenties (in the Ministry of Education) and in the period 1936-1958 (in other Ministries) Portugal had created research councils or similar bodies for several sectors of activity, but the practical benefits did not very often correspond to the aims expressed by the legislation. And in 1967, during the work of the pilot-team mentioned above, another body was created, this time under the Prime Minister – a National Board for Scientific and Technological Research (in Portuguese, the "Junta Nacional de Investigação Científica e Tecnológica", JNICT) for planning, coordination and encouragement of research in the country.

1.3 In a long report presented to the Government in February 1968, the Portuguese pilot-team (of which I myself was the director) made many recommendations to improve the situation, such as reforms in the higher education system and in the organization of research, definition of some priorities, increasing of resources. The aim for 1980 was the allocation of 1% of GNP to R & D, with 4.5 researchers per 10 000 inhabitants.

These quantitative targets soon revealed very utopian, but some improvements were made, namely, the simplification of the requirements to get a Ph.D and to be promoted in the academic career at the universities – requirements that were very hard before, apart from the very low wages of the teaching staff; new universities and some polytechnics were created, the number of fellowships to study abroad were increased. And other measures were about to be taken when the 1974 revolution came and the process was interrupted.

So, in spite of the great progresses made since the end of the sixties (many more Ph.D's, an increasing number of articles in well known journals), the scientific system could be characterized, 20 years later (1990) in the following way:

i) Very limited financial and human resources by European standards (Table 2).

ii) Underemployment of highly qualified staff members as a result of a lack of technical and auxiliary personnel, specially in the higher education sector.

iii) Weak links between the scientific and technological system and productivity activities (this aspect was being improved through better relations between the universities and State laboratories and industry).

iv) High degree of technological and scientific dependence, with a lot of royalties and many Ph.D's obtained abroad (this situation too was getting better with the creation of regular post-graduate courses in the country and the shortening of the training abroad).

v) Ambiguity in the definitions of the bodies co-ordinating and promoting research, with useless duplications.

vi) Non existence of an overall scientific and technological policy, in spite of the many intentions to define it.

vii) A non uniform distribution of resources within the country, with the region of Lisbon and Tagus Valley highly favoured with respect to the rest of the country: 30% of the population, but 64% of expenditure and 65% of personnel on R & D.

viii) The Government provided the main source of funding (62%) followed by enterprises (with only 27%, a level well below those of most EU countries).

1.4 As a member of NATO, Portugal has profited from its scientific programmes, specially the "Science for Stability" dedicated to Greece, Portugal and Turkey. It was a founding member of international organizations devoted to science and its applications, such as ICSU and ESF. Its affiliation to CERN took place in 1995, after a period of special association since 1981. For a long time it had taken part in the COST programmes and the participation in these community initiatives was, naturally, increased when it became a member of the European Community, in 1986. However, in the following decade (1986-1995) the Government thought that this participation was enough and very little money from the State Budget was dedicated to scientific researches not included in the EC programmes. As a consequence, the basic research suffered very much. Even the research council within the Ministry of Education, with more than 60 years of existence, was extinguished in 1992; and at the same time the Academy of Sciences of Lisbon, with Classes of Sciences and Letters, was put under the dependence of the Ministry of Planning and Administration of the Territory, with such a small budget that, being a member of ICSU and ESF, it cannot take profit of the initiatives of these organizations, allowing only to promote the very few cultural exchanges with other academies.

2. THE CURRENT SITUATION

In 1995, with a new Government, a Ministry of Science and Technology was created; and to surpass the fragilities of the Portuguese scientific system, well known from previous studies, we can point out as important features of the policy of the new Ministry:

a) At organizational level: the JNICT, that was (by law) the central body of coordination of research, was split into three new bodies: an Observatory of the Sciences and Techonologies, an Institute for International Scientific and Technological Cooperation and a Foundation for Science and Technology.

b) Evaluation of the research: some international criteria were set up for the evaluation of the State laboratories and research centres at the Universities of projects (with the corresponding financing), with the intervention of scientists from abroad.

c) Stability on the working of the institutions: creation of mechanisms of pluriannual financing and publication of new statutes for the career of researchers and for fellowships.

d) Technological capacity of the enterprises: for the strengthening of this capacity, some programmes of applied research were developed through protocols between the State and groups of enterprises, with periodic evaluations; better relations between the enterprises and technological centres, universities and other research institutions were promoted; some fiscal benefits for the R & D activities were created; and an encouragement for innovation and internationalization also came through initiatives like the EUREKA-Asia.

e) Scientific culture: since the population shows a deficit of scientific culture when compared with other European countries, mainly because of the system of education, some initiatives were set up to improve the situation, namely the programme "CIÊNCIA VIVA" (Living Science) to promote the contact of young people and secondary schools with research centres of universities and others during the Summer (calling the attention to the great importance of the experimentation in the teaching of sciences) and the introduction of INTERNET in the secondary schools and many basic schools.

f) Financial resources: After some years of stagnation (0.63% of GDP in 1992, 0.61% in 1995) the expenditure on R & D shows a good increase since 1995 (0.68% of GDP in 1997), with attenuation of the asymmetry within the country, mainly due to the intervention of research units of the higher education and private sectors (the percentage of resources in the region of Lisbon and Tagus Valley was 67% in 1988, 64% in 1990, 57% in 1995, 56% in 1997). See Table 3.

For the distribution of expenditure on R & D by sectors of activity and by scientific and technological domains see Table 4 and Table 5.

g) Human resources: The rate of growth of human resources since 1990 is greater than that of financial resources and in 1997 the number of researchers was 2.9 ‰ of active population, with 3.9 ‰ of total personnel on R & D. The number of scientific papers by Portuguese scientists with international citations has been increasing steadily (specially in Physics, Chemistry, Medical, Biomedical, Earth and Space Sciences), with more articles per scientist and with about half of the articles in collaboration with foreign researchers. In Social Sciences, however, the number is yet very low and only in Economics, Management and Psychology.

The Portuguese can now benefit from recent affiliations of Portugal in organizations like EMBL, ESRF, ODP, ESA, besides the reinforcement of the collaboration with CERN and ESO.

h) Finally, included in the Plan of Economic and Social Development for 2000- - 2006, the Ministry of Science and Technology has two operational programmes: "Science, Technology and Innovation" and "Society of Information". The main objectives comprise the reinforcement of scientific institutions by the creation of new institutions (like a National Institute of Biomedical Research and a National Net Library for Science and Technology), continuation of periodic evaluations, programmes of advanced training, introduction of post graduate people (Masters and Ph.D's) in the enterprises, and the continuation of the programme "CIÊNCIA VIVA", today with the participation of half a million young people and more than 2000 schools.

Table 1

Expenditure on R & D and researchers
5 countries of the pilot-team project versus 5 other European countries

Country	Year	Expenditure on R & D % GNP	Researchers FTE Per 10 000 inhab.
Belgian	1963	0.9	6
France	1963	1.6	7
Germany (W)	1964	1.4	6
Netherlands	1964	1.9	8
U.K.	1964/65	2.3	11
Greece	1964	0.2	1
Ireland	1963	0.5	3
Italy	1963	0.6	4
Portugal	*1964*	*0.3*	*1.3*
Spain	1963	0.2	—

Table 2

Expenditure and human resources on R & D – 1990 or year next to

Country	Exp. R & D, % GDP (A)	Human Res. (FTE), ‰ Act. Pop.		(A)/(B)
		Researchers	Total (B)	
Belgian	1.7	4.4	9.3	0.18
France	2.4	5.1	12.0	0.20
Germany (W)	2.8	5.9	14.3	0.20
Netherlands	2.1	4.0	9.9	0.21
U.K.	2.2	4.6	9.8	0.22
Greece	0.5	1.4	2.4	0.21
Ireland	0.9	3.0	4.8	0.19
Italy	1.3	3.2	6.0	0.22
Portugal	0.6	1.4	2.5	0.24
Spain	0.8	2.2	3.8	0.21

Table 3

Gross Domestic Expenditure on R&D (GERD) (1995 – 2000**)**
(current prices, 10^6 National Currency)

	1995	1997	1999
GERD	92 229	115 655	163 342
C.A.G.R.*		12,0%	18,8%
% GDP**	0,6	0,6	0,8

Sources:
Observatório das Ciências e das Tecnologias, Inquénto so Potencial Cientifico Nacional
OCDE, Principaux Indicateurs de la Science et de la Technologie, 2000(2) – Base de données
* Compound Annual Growth Rate
** GDP values published in Principaux Indicateurs de la Science et de la Technologie, 2000(2) – Base de données.

Table 4

Distribution (%) of expenditure R&D by sector of activity – 1997

Performance Financing	Enterprises	Government	Higher Ed.	Priv. non-pr.	Total financing
Enterprises	82	4	2	7	21
Government	10	88	90	65	68
Higher Educ.	—	—	4	—	2
Priv. non-profit	—	1	1	16	3
Foreign	8	6	3	12	6
Total Perform.	22	24	41	13	100

Table 5

Distribution (%) of GERD
by S&T domains and performing sectors (enterprises excluded) – 1999

Performing Sectors S&T Domains	Government	Higher Education	Priv. non-pr.	Total
Exact Sciences	8	16	8	12
Natural Sciences	18	14	14	15
Engineering and Technologies	31	21	41	27
Health Sciences	11	10	14	11
Agrarian and Veterinarian Sc.	22	8	6	13
Social Sc. and Humanities	10	32	17	22
Total	100	100	100	100

Key words:

Technical capacity of enterprises
Low level of financing by industry
Academic-industry links
Innovation
Internationalization
Evaluation of research
Regional asymmetry of resources
Lack of technical and auxiliary personnel
Weak public understanding of science
Public education – scientific culture

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SLOVENIA IN TRANSITION: WITHOUT R&D STRATEGY

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INTRODUCTION

The Slovenian transition process started with the plebiscite on December 23rd, 1990, and on July 25th, 1991 followed the proclamation of the Republic of Slovenia (RS) as an independent and sovereign state. The RS constitution was published on December 28th, 1991. With the plebiscite Slovenia left the Socialist Federal Republic of Yugoslavia and after the proclamation of independence started the transformation process towards a democratic society, recognizing and fostering free market economy, human rights and religious beliefs of every individual. Consequently, the economy transition started from the centralized state towards a free and open market economy. The Slovenia secession from Yugoslavia and the socialist economy resulted in trade blockade and imposed barriers from Yugoslavia and other socialist states. Slovenian economy has lost the major markets and suppliers. The survival solution was to transform the economy towards Western free and open markets, European Union and neighbouring countries. Western free economy markets accepted only high quality and modern technology products.

The Slovenian economy and industry underwent the transition to new markets by introducing new technologies, products and services. This was carried out with many accompanying difficulties. Rapid rise of unemployment, some companies were closed, some reduced drastically and only the market demanded product lines remained operational. All non vital operations were stopped, dismissed and even sold to provide capital for new investments, but they also required industry modernization. Many companies dismantled their research and development (R&D) departments. The research work in Slovenia was hurt by this process in two ways. First, the state income was considerably reduced and owing to it less funding was available for the public needs as well as for the research work. Secondly, research and development co-operations and orders from the economy and/or industry were reduced. Research work at universities, research institutes and all other research entities underwent serious shortage of means. The scarce funding of institutions was entirely dependent on state funding and the rather negligible research orders from domestic economy. These conditions lasted for several years and caused research institutions to change and/or reduce their size and operations by different measures like the retirement of personnel, the migration of researchers to industry or to entrepreneurial and other free market employment possibilities. This brief report describes the transition process reflections on R&D in Slovenia and how the research potential was in spite of large difficulties preserved to a great deal.

MANY UNKNOWN VARIABLES: TACTICS REPLACES STRATEGY

The first years after declaration of independence in Slovenia were rather hectic, particularly considering the economic developments. Many institutions stopped their operations, companies struggled for survival and changed their operations. The consequences of insolvency were layoffs but also numerous bankruptcies. In such times economic prediction is impossible and the course can not be estimated. Therefore, a strategy for covering the several years of activities planning is difficult. Also, the governmental priorities mirrored the said and were devoted to more essential issues like securing the functioning of society, sovereignty and build up of national armed forces. In these circumstances the R&D did not rank high priority. The governmental decisions were made more on the grounds to overcome critical situation developments and on the run with utilizing sound tactics. The Ministry of Science and Technology operated by following the momentum of previous years and the maintaining of operations and did not concentrate on essential strategic approaches and changes. There were attempts of strategic decision makings like the preservation of good research establishments, research institutes of national importance and the supporting research of Slovenian natural and cultural heritage, preservation of environment and limiting the pollution. Debates along the lines of research organization and the R&D funding started to be with time more and more difficult. This was due to social and high unemployment reasons, if at that time a fundamental restructuring started it may be faced with many opposing views and strong political lobbying against stricter reforms. The problem of research reorganizations is difficult and needs a broad democratic approach, based on sound solutions, but the discussion in this regard was not completed so far. The described difficulties are mirrored in the fact that during the period of ten years of independence the ministers of Science and Technology were replaced five times and this was accompanied by entirely changed approaches to R&D strategy. Also, the process of adopting the needed law on Science organization and R&D funding for nearly eight years did not succeed. The third completely new R&D written version is currently in the process of adoption. Owing to it the law adopted in a hurry in 1992 is still used in spite of its shortcomings to deal with the emerging complexity caused by developing and rapid changing of society relations but also of EU harmonization.

Already in 1994 the unpleasant and large transition changes started to normalize. Some decision makings based on sound reasoning followed, but an overall planning or medium term strategy was not introduced in the R&D area. For the understanding of current relations in Slovenian R&D, its organization and funding, the introduced changes and the development from 1995 until present are instructive.

THE NATIONAL RESEARCH PROGRAM AND TECHNOLOGY FORESIGHT ACTIVITIES

The National Research Program (NRP) was adopted in the Parliament and publicly announced on January 24th, 1995. During 1994, an extensive debate about the composition and highlights of the research development in Slovenia was carried out.

The NRP specified the R&D goals and the funding changes and priorities. Important was a decision that the R&D spending will be incremented annually by 10 % until it reaches 2,5 % of GNP around the year 2000. This sum may be composed of more than 1,25 % of GNP provided by the public funding and the rest by private industry and others. The medium term aims and goals were specified particularly in regard to the education and improving of researchers` training, research infrastructure and transfer for knowledge. This program stressed not only the maintaining of research facilities and their up-grading with modernization, but also the spin-off of knowledge and facilities into companies. Today, it is evident that the transition did not substantially change the landscape of publicly funded research institutes, because nearly all remained operational and did not change much. There was an important change towards higher quality of all R&D activities including internationalization and mobility of researchers. Important was also the program and activities for educating talented young researchers which seemed to have significantly contributed to the easier survival of most research institutes and laboratories. It is also obvious that in Slovenia R&D priorities were not explicitly and by area enough clearly defined and consequently the research activities were too scattered to be of significant help to economy or industry.

The gross national income per capita was gradually rising every year and it partly compensated the almost unchanged amount of governmental R&D funding. In 1992 it was already at 0,66 % of GNP, rose in 1993 to 0,72 %, rose again in 1995 to 0,73 %, but in 1996 dropped to 0,62 % and climbed gradually until 1998 to 0,68 % of GNP. Grossly the R&D funding remained the last ten years on the mark of around 0,7 % of GNP (reported by the RS Parliament, Ljubljana, October 1998). It is not yet known and was never publicly explained why the Government and the Parliament decided and adopted a different course in R&D funding and have not followed the already planned and by the Parliament endorsed NRP with funding scheme. Speculations in this regard are many, such as changed priorities but also shortage of money due to rapid increase of public and governmental spending, which prevented larger state R&D funding. Official statistical data show that in addition to the public R&D funding other non governmental institutions (economy, industry) are co-funding R&D to nearly the same amount. The OECD and Eurostat data show that in 1998 the Slovenian total funding of R&D was about 1,42 % of GNP and among the highest when compared with other transition countries. The Slovenian R&D funding supersedes some EU countries (European Commission research data, Key Figures 2001) in comparison with Greece 0,51%, Portugal 0,78 %, Spain 0,90 %, Italy 1,04 %, Ireland 1,39 %, and is lower in comparison with Austria 1,78 %, Belgium 1,98 %, UK 1,87 %, Denmark 2,07 %. The Slovenian R&D spending is quite lower if compared with the EU average of 1,92 % and substantially smaller when compared with Sweden 3,70 %, Japan 2,91 % and USA 2,62 % of GNP, the countries which spend large amounts for science funding.

For the most of transition years the economy demand for R&D activities was low. The R&D groups, universities and institutes redirected their attention to basic research and publishing of research articles. The volume of SCI (Science citation index) articles has positively increased, but the rise of world competitiveness of Slovenian economy was not significant. The immediate support of Slovenian R&D to economy, industry, and growth is rather small and of great concern. Due to such developments the political as well as public opinion and support to R&D dropped to a low level. This is mirrored also in the unchanged or relatively low allocation of funding by the Parliament. The World Competitiveness Yearbook 2001 (International Institute for Management Development, IMD, Switzerland, http://www.imd.ch.wcy) ranked Slovenia among 47 leading countries to the 45th place. The grading of R&D institutions collaboration with economic-industry sector is similarly low and indicates that the productivity and efficiency of R&D with knowledge transfer needs improvements.

Technology foresight activities in Slovenia started in 1998 and in 1999 a coordination group was formed, which organized different activities in 2000 and is responsible for the planning. The activities for the Slovenian foresight plan called Foresight-Slotech 2010 have started and may be completed in 2002.

The R&D groups, universities and research institutes are showing great interest for co-operations in the EU programs. According to the statistics for the 5th Frame -Work Program and for the funding accepted applications the success rate was around 10

%, and in some thematic areas considerably higher. Figures indicate that the R&D potential in Slovenia was not essentially affected by the governmental policy and economic transition process. Therefore, the existing and vital R&D base in Slovenia could be of important support to the expected and very necessary rise of added value in the economy and industry. Owing to it an important economic growth potential could be triggered by sound co-operation of R&D institutions with the economy and industry.

The statistical data highlight nicely the above set. By EUROSTAT data for 1998 the R&D expenditure of 1,42% GDP is among the highest of EU candidate countries, indicating that Slovenia may reach the EU-15 average soon. At the same time the R&D personnel statistics shows a mild decrease of 4,2%. The data show also a rather interesting level for Slovenia in GDP per capita in thousands of Purchasing Power Standards (PPS) for 1999, being with about 15% the second country among the candidate countries. The GDP per capita is 71% of EU average and ranks Slovenia rather high compared to other candidate countries. The data of the gross value added, employment, remuneration and labor productivity are not in a significant up-swing in spite of the fact that Slovenia has a high labor productivity. Today, it is commonly accepted that Slovenia has not yet developed a detailed innovation policy. Currently a general view shows that numerous regulations and programs were or are being in preparation for adopting a good structured innovation policy while at the same time it seems that the funding support is not yet elaborated to a convincing level. For supporting of this view let us mention that in Slovenia during 2001 the legislation and governmental emphasis was made to develop the national development, research, education and innovation policies. In this context the National Development Plan was prepared and entered the phase of parliamentary approval. In parallel the National Research Program has been prepared in accordance with the Technology Foresight which is also in preparation. It is very supportive that the Master Plan for Higher Education is already in parliamentary approval. Thus, a set of very important and underpinning documents defining much better and in detail the national research strategy will pivot measures for further progress and R&D growth. In this regard it is positive that most of these documents prescribe and regulate also the funding for the foreseen measures and planned developments.

CONCLUSION

The first ten years of transition Slovenia did not utilize a specific and formulated science strategy. There was a consensus along the lines for preserving and maintaining the R&D potential. This was enabled by scarce, yet still sufficient public funding. In the last years requests for a more accountable, responsive and better R&D as well as transfer of knowledge are growing. The needs for concentrating R&D activities for better enabling international competitiveness and larger projects realizations are rising and materializing in documents which also better define the development and research strategy. The R&D areas in Slovenia could profit by more internationalized and transparent funding evaluation and justification procedures which should be aiming to improvements in quality, efficiency, inventiveness and competitiveness. In this regard also activities for national consensus and preparations of the Foresight-Slotech 2010 are essential because of supporting the needed focusing and concentration of R&D activities in Slovenia. Also, a positive move is expected by the adoption of a modernized law on the R&D. It is our hope that with the adoption of this new law and the National Development Plan an up-swing of science and economy in Slovenia may be triggered.