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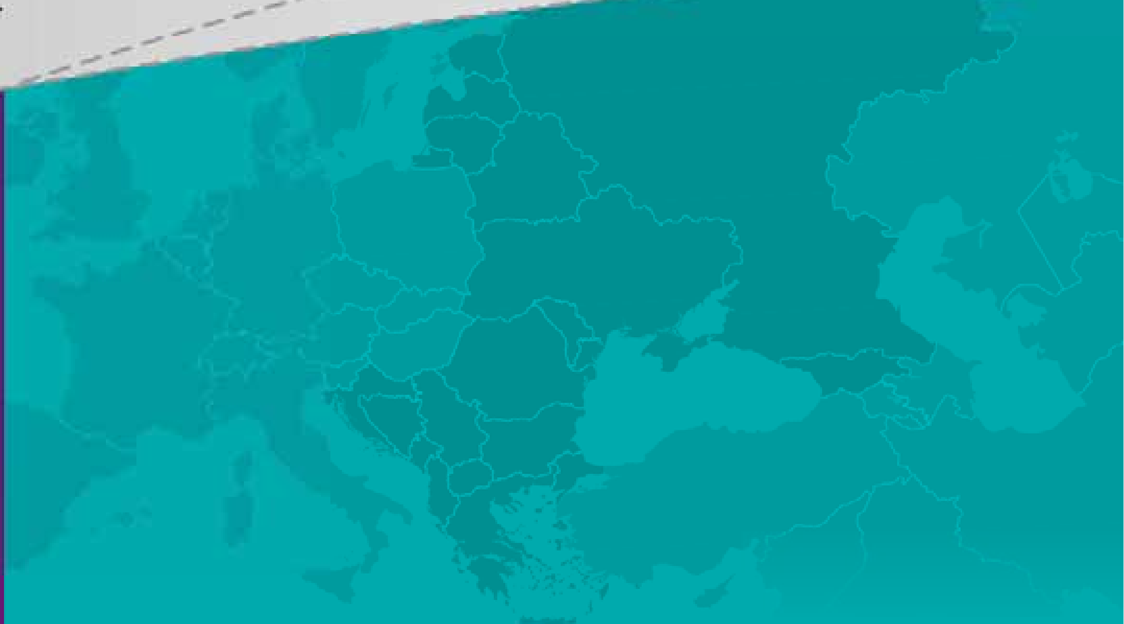

Science and Education Policies in Central and Eastern Europe, Balkans, Caucasus and Baltic Countries

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Contents

List of Acronyms

ALLEA	All European Academies
ASA	Academy of Sciences of Albania
ALYS	Association of Latvian Young Scientists
BSEC	Black Sea Economic Cooperation
CEI	Central European Initiative
CELIP	Central and Eastern European Licensing Information Platform
CERN	European Organization for Nuclear Research
CERTH	The Centre for Research & Technology 'Hellas'
CG	Cultural Goods
CI	Cultural institutions
COST	European Cooperation in the Field of Scientific and Technical Research
CRDF	Civilian Research and Development Foundation
DA	Direct audience; Direct access
DC	Digitized Content
DFG	German Research Foundation
DLI	Digital Library Initiative
EA	Extended Audience
EC	European Commission
ECTS	European Credit Transfer and Accumulation System
EIT	European Institute for Innovation and Technology
EFTA	European Free Trade Association
EHEA	European Higher Education Area
ENP	European Neighbourhood Policy
ERA	European Research Area
EU	European Union
EUREKA	pan-European network for Market-oriented Industrial R&D
FP	Framework Programme
GDP	Gross Domestic Product
GRP	Global Research Partnership
IAP	Inter Academy Panel
ICBSS	International Centre for Black Sea Studies
ICGEB	International Centre for Genetic Engineering and Biotechnology
ICS-UNIDO	International Centre for Science and High Technology of UNIDO
ICTP	'Abdus Salam' International Centre for Theoretical Physics
IDA	Indirect Distance Access
IOM	International Organization for Migration
JARA	Jülich-Aachen Research Alliance
JINR	Joint Institute for Nuclear Research
KAUST	King Abdullah University of Science and Technology

KIT	Karlsruhe Institute of Technology
MRDA	Moldovian Research and Development Association
NATO	North Atlantic Treaty Organization
NO	Network Operators
NSF	National Science Foundation
NTCG	New Transformers of Cultural Goods
OCDE	Organization for Economic Co-operation and Development
ONRG	Office of Naval Research Global
OSCE	Organization for Security and Co-operation in Europe
SASA	Serbian Academy of Science and Arts
SEE-ERA.NET	South East Europe – European Research Area Network
SISSA	International School for Advanced Studies
SP	service providers
STCU	Science and Technology Centre in Ukraine
STEM	science, technology, engineering, mathematics
STEPS	S&T Potential Studies
TEI	Text Encoding Initiative
TTCG	traditional transformers of cultural goods
UNESCO	United Nations Educational, Scientific and Cultural Organization
VA	virtual audience
TWAS	Academy of Sciences for the Developing World
WAYS	World Association of Young Scientists
WAG	Washington Advisory Group
WMD	Weapons of Mass Destruction
WTO	World Trade organization
WBC-INCO.NET	Western Balkan Countries – International Cooperation Network

Foreword

Building the future through Science and Education represents a major challenge for all countries, especially for Eastern and South Eastern European (E&SEE) countries. In this process Science and Education appear as an effective tool in facing national and regional challenges such as improving the quality of life, environmental sustainability, health conditions, economic stabilization and growth as well as integration into European and world cooperation.

The transformation of society, which is a common feature of almost all countries of the region, has given additional weight to the role of national policy, which now has a new opportunity to contribute, with its legislative work on science and higher education issues, to the common task of bringing enhanced economic and social progress in the entire region. The task ahead is the adoption of reforms that address new dimensions of Science and Education (S&E) Systems and, by means of this, also the responsibility for directing the entire development of societies.

Modern science and higher education governance is characterised at national and international levels by a number of serious challenges for policy-makers, such as:

- understanding and managing the complexity and uncertainty of science and education;
- responding to a new environmental, ethical and societal demands;
- finding an appropriate balance between public and private funding;
- ensuring an adequate infrastructure for the development of science and education;
- assure the free flow and exchange of scientific information;
- improve science and technology policy's coherence and consistence through finding new forms of interaction between the scientific community, policy-makers and society as well as new institutional arrangements between the different areas of governance;
- creating participatory processes in S&E decision-making, involving a large number of partners integrating both the infra-national and supra-national dimensions;
- integrating future oriented, creative, non-linear thinking in decision-making.

By re-establishing links between science and society as a means of coping with public fears and concerns, countries can address an increasing number of issues that require extensive knowledge on Science and Technology (S&T) for effective legislative process. These include issues on environment, new information and communication technologies, agriculture, energy, and health care, to name but a few. I will briefly explain the above concepts below:

Shared responsibility and cooperate governance

Modern life has raised new ethical responsibilities. As expertise is no longer exclusively possessed or controlled by official organisations, citizens are becoming engaged in the deliberative processes of science-related governance issues.

National Science and Education Policy Strategy
National strategies should be developed in cooperation between Parliaments, scientific community and society, including the target of developing *knowledge society* and *brain gain* actions as a foundation for sustainable development of countries.

Knowledge transfer: Improving information and dialogue between stakeholders
States require for their policy-making and oversight roles in S&T, new types of information and modes for organizing such information.

Institutionalize knowledge transfer
Ministries should take a lead in increasing public discussion and awareness about new major scientific issues through hearings and inquiries as well as other forms of public engagement. They should also involve the scientific and education institutions, such as the Academies, Research Centers and Universities, in the policy-making process.

Increase Transparency
Transparency of the legislative process in science and higher education is a condition *sine qua non* of the participative democracy.

Assessment of science and higher education activities
An assessment of scientific and educational activities is needed at national level through evidence-based tools, including indicators, as well as a performance monitoring.

Create leadership
All countries are asked to invest in science, higher education and innovation at national level, as well as to initiate or develop cooperation at sub-regional and international levels.

All the above mentioned trends are at the heart of UNESCO's action in the field of science policy. Through its Venice and Moscow Offices, UNESCO offers to the E&SEE countries the opportunity to address these issues through dedicated national and regional activities. Several regional initiatives, aimed at enhancing E&SEE countries capacities in the field of science, higher education and innovation through platforms for dialogue and cooperation have been organized in previous years: *International Conference and Round Table of Ministers: Why Invest in Science in SEE?, September 2006, Ljubljana, Slovenia,* International Conference *Global Science and National Policies: the Role of Academies*, May 2007, Chisinau, Republic of Moldova, *Science Policy Forum: Science for the Future, Science for Society. The Parliamentary Perspective*, June 2007 in Bucharest & Tulcea, Romania, *Science, Higher Education and Innovation Policy Forum and Ministerial Roundtable,* July 2008, Budva, Montenegro.

The Conference 'Science and Higher Education Policies in Central and Eastern Europe, Balkans, Caucasus and Baltic Countries' organized in Chisinau in September 2008 brought together all the important policy-making actors: Ministerial representatives, Universities, Academies, Parliamentarians in an attempt to debate and reach consensus on how to better interact and address together challenges of socio-economic development at national and regional level. Another goal of the event was the adoption of a forward-looking approach of higher education, science and innovation governance with a view to contribute to the building of knowledge society in the region.

The conclusions elaborated constitute a major input to several high-level events organized by UNESCO namely: UNESCO Forum on Higher Education in the Europe Region: 'Access, Values, Quality and Competitiveness', May 2009, Bucharest, Romania, *World Conference on Higher Education*, July 2009, UNESCO, Paris*, World Conference on Science*, November 2009, Budapest, Hungary, *Science and Higher Education Ministerial Round Table*, May 2010, Tirana, Albania.

UNESCO and its Offices in Venice and Moscow will further support and facilitate the process of science and higher education governance in order to contribute at enhancing the opportunities of E&SEE member States to take an active part in world class international science, education and innovation activities.

Engelbert Ruoss
Director, UNESCO BRESCE

Introduction

Every society today is aiming towards building an economically competitive and sustainable society – a knowledge-based society – a society that thrives on education, scientific research and technological innovation, displacing traditional factors of economic growth with knowledge.

The 'Science and Education Policies' Conference, organized by joint efforts of the Academy of Sciences of Moldova and the Ministry of Education and Youth of the Republic of Moldova, with the support of the UNESCO Office in Moscow, Central European Initiative, the U.S. Civilian Research and Development Foundation (CRDF), Office of Naval Research Global (ONRG) and Moldovan Research and Development Association (MRDA) and others, was conceived as a forum for exchanging ideas, experiences and achievements with the goal of developing better science and higher education policies, as well as for creating an excellent opportunity for networking, collaboration, sharing of information and the building of trust relationships internationally. We believe that these ambitious goals were fully reached.

The 'Science and Education Policies' Conference was a follow-up to the International Conference of the Academies of Eastern and South Eastern Europe on 'Global Science and National Policies: the Role of Academies' organized by the UNESCO Office in Venice (BRESCE), the UNESCO Office in Moscow and the International Council for Science (ICSU) and hosted by the Academy of Sciences of Moldova in Chisinau, Republic of Moldova, 4-5 May 2007. It was officially included in the Calendar of Events of the Moldovan Presidency to the South East European Co-operation Process (SEECP). It brought together key decision-makers in national science and education policy from more than twenty countries of the Central and Eastern Europe, Balkans, Caucasus and Baltic States, in particular Presidents of the Academies of Sciences and Ministers of Science and Education, participating or represented, as well as representatives of international organizations from the above-mentioned regions, including representatives of the European Commission and experts from United States.

The programme of the Conference addressed several challenges affecting science and higher education policies nowadays, mainly:

- Session I 'Strengthening international impact of national research and education programmes' confirmed once again that a country's national education and research programmes play a crucial role in answering national challenges in a global context;
- Session II 'Strengthening research in higher education' exemplified various national incentives for increasing the synergy between research and education, stressing the importance of an integrated approach;
- Session III 'Developing a knowledge-based economy' discussed several methods and techniques for the development of science and technology in the context of a knowledge-based economy; and

- Session IV 'Stemming and reversing brain drain' addressed the issue of human capital mobility and common problems within the region represented, which resulted in proposing some common solutions.

During this Conference, the participants analyzed the latest scientific achievements related to the various topics and elaborated practical solutions and recommendations for decision-makers. Representing a follow-up to the Conference focusing on the role of Academies within global science and national policies, the Conference on Science and Education Policies focused on in-depth discussions on subjects linked with science and education that are common to the entire region. Through an expanded regional cooperation a broad range of global issues can be met, thus fostering the way towards sustainable development.

Science is a reliable source of objective knowledge and expertise, while education performs its role in training future researchers, strengthening human resources in science and technology. Nobody will deny today the value of educational activity realized by the researchers as well as the scientific work done by educational staff. Nowadays, both education and science face the challenge of increasing the interest in science among youth, improving the quality of scientific teaching and encouraging creativity.

As a result of the Conference, the participants adopted unanimously two important documents which we believe will serve as useful tools for decision-makers in the regions represented and beyond:
- The Conference Declaration, emphasizing the importance of these type of events aiming at bridging the gap between decision-makers and the scientific community; and the
- Final Communiqué, synthesizing the quintessence of the Conference presentations and discussions, as agreed by the participants.

We truly believe that the goals of the Conference were achieved and the results will serve as a valuable background for the next regional conferences in this field.

Gheorghe DUCA
President of the Academy of Sciences of Moldova

CHAPTER I

Strengthening the International Impact of National Research & Education Programmes

The Challenge of Strengthening the International Impact of Research and Education Programmes and how the European Community's 7th Research Framework Programme Has Answered It

Zoran STANČIČ
Deputy-Director General,
DG Research, European Commission

I take the opportunity to talk about the challenges before us if we wish to strengthen the international impact of research and higher education programmes, policies and systems and how the European Union (EU) tries to address them.

I will focus on some challenges for the reform of Europe's research and higher education systems and elaborate on progress. I will inform about some core aspects of the EU's strategy to address these challenges, and will finally mention recent initiatives of the Commission to further increase Europe's performance in research, education and innovation.

Let me start by acknowledging that we face the same challenges all over Europe today: globalisation, global societal challenges, and the need to reform our education and research systems, all call for concerted responses in order to proceed successfully towards knowledge-based societies.

Governments have acknowledged these challenges and understand that more high-level skills and research are needed in an advanced knowledge economy. Today, a much greater proportion of the workforce than previously has to be educated beyond the secondary school level.

If you want to acquire excellence in research, education and science you will need both:

- strengthen the impact of research and education programmes, and policies internationally;
- and foster international cooperation.

The reform of research and education systems must be part of the strategy to achieve this.

This is definitely a challenge, particularly for countries that are in a transition phase, like most of the countries in this region. But let us not forget that EU member States face the same or very similar challenges.

For that reason, EU member States agreed, as part of the Lisbon Strategy for Growth and Jobs, to reform their education and higher education systems by working towards five common objectives. The most important are the following:

- at least 85% of young people in the EU should have completed upper secondary education;
- 12.5% of the adult population should participate in lifelong learning;
- and the number of tertiary graduates in Mathematics, Science and Technology should increase by at least 15% by 2010.

Progress towards these objectives is monitored each year by the Commission through 16 indicators on which the EU member States agreed in May 2007. These core indicators, which include for example 'upper secondary completion rates of young people', 'cross-national mobility of students in higher education', and 'investment in education and training', cover the whole learning continuum. The latest monitoring exercise of the Commission indicates progress but the pace of reform in general remains rather slow. This is why EU members States need to redouble their efforts to make the EU's education and training meet the challenges of the 21st century particularly, with regard to investment in human capital.

While the overall pace in the EU member States remains slow, performance varies significantly across the Union. Figures show best performers that are faster than the other EU member States. Let me give you two examples:

- in the case of *participation in lifelong leaning by adults*, Sweden, Denmark, and the United Kingdom perform best, having a participation rate between 26% and 32%, while the benchmark at Community level is 12.5%;
- the case of *graduates from upper secondary school* shows a very different picture: here the Czech Republic, Poland, and Slovakia are ahead of the others, with graduation rates of about 92%, the benchmark being 85%.

A similar differentiation can be observed when comparing the *performance of national research systems* in Europe: while for example Sweden and Finland are clearly leading with regard to R&D investment as a percentage of GDP, Ireland and France show the highest number of graduates in scientific and technological studies per 1.000 population.

I would like to invite you to consider our efforts to achieve the so-called 3%-target for R&D investment also a target for your countries. Agreeing on and pursuing such a target will help you to substantially increase your commitment to stimulate R&D and innovation.

Comparing the performances globally, it is important to note that on several indicators, both with regard to education and research, Europe shows a better performance than the US or Japan.

Also as part of the Lisbon Strategy the European Commission has, in 2006, published a political document proposing 'a modernisation agenda for universities'.

The modernisation of universities includes a *Curricular reform* (the three cycle system 'bachelor-master-doctorate', competence based learning, flexible learning paths, recognition, mobility), a *Governance reform* (University autonomy, strategic public-private-partnerships, quality assurance in education and research) and a *Funding reform* (diversified sources of university income better linked to performance, promoting equity, access and efficiency, including the possible role of tuition fees, grants and loans).

To make the most of these modernisation activities member States, Universities and the Commission coordinate their actions.

Outside the Union's framework, the Bologna Process, which was initiated in 1999, complements the policy followed within the EU. The Bologna Process promotes curricular reforms in 46 European countries that work together towards establishing the European Higher Education Area by 2010. Participating countries include the Republic of Moldova and the other European Neighbourhood Partner countries (not Belarus), all potential candidate and candidate countries as well as the Russian Federation. The main objectives of this process are the introduction of the three cycle system 'bachelor/master/doctorate', quality assurance and the recognition of qualifications and periods of study. Since 2007, when 'Bologna ministers' approved a 'global Strategy', the international dimension has played a central role for the Bologna process. The Strategy aims to open European higher education internationally and promote the attractiveness of higher education worldwide through, for example, intensified dialogue, information and international partnership.

The Commission recognises these reform needs. We think that the best way to significantly increase the ability to respond to the challenges of the knowledge society today is to integrate the three dimensions of education, research and innovation – which form the so-called 'knowledge triangle'. The Community supports the enforcement of the 'knowledge triangle' through several policies and instruments, which are not exclusively addressed to EU member States but also to potential participants in your region: the Seventh Framework Programme for Research, international mobility schemes, and the European Institute for Innovation and Technology are only the best examples of those.

The *Framework Programme* invites researchers from all over the world to participate in collaborative research projects; it also offers funding for 'third country' researchers. Through its 'People Specific Programme' it provides international fellowships for your researchers either to come to the EU or to go from the EU to one of your countries.

For countries covered by the European Neighbourhood Policy or that have signed a bilateral S&T Agreement with the Community, the new *International Research Staff Exchange Scheme (IRSES)*, is of particular importance. IRSES is directly targeted at creating better structural links between institutions within the European Research Area and those partner countries with preferential relations.

But the Commission does more to reinforce your research and education systems: Since 1990, the *TEMPUS Programme* has enabled universities from EU Member states to cooperate with those in the Western Balkans, Eastern Europe, Central Asia and the Mediterranean region in higher education modernisation projects. The new Tempus programme (2007 to 2013) retains its strong focus on institutional cooperation. Important for you is that we envisage an extension of the on-going policy dialogue and a closer involvement of third country decision-makers in various programme stages such as the definition of national priorities or of action plans.

Another EU instrument in the field of higher education is the *ERASMUS MUNDUS Programme*. Since 2004 it has promoted co-operation and mobility in the higher education sector with a view to enhance quality, visibility and attractiveness of European higher education in third countries. Beginning in 2006 the new 'Erasmus Mundus External Cooperation Window' promotes the exchange of persons, knowledge and skills at higher education level between the EU and third countries.

As you can easily see, the Commission considers institutional cooperation and the international mobility of researchers and students essential to strengthen research and education programmes and systems nationally, European-wide, and internationally. Therefore, I strongly encourage you to increase your participation in the just mentioned activities. Let me be clear: We understand the European Research Area as being open to the rest of the world and not as a European Research 'Fortress'!

Another important instrument to enforce the 'knowledge triangle' should be highlighted here: the *European Institute for Innovation and Technology (EIT).* The EIT, which is operational now, with its seat in Budapest, is notably the first European initiative to integrate fully the three sides of the 'knowledge triangle'. It will inspire and drive change in existing higher education and research institutions. The EIT will be based on highly-integrated and excellence-driven partnerships between universities, research organisations, and business, the so-called 'knowledge and innovation communities'. 'Knowledge and innovation communities' will work together and maintain links with organisations from all over Europe for a period of 7 to 15 years, gathering 'the best of Europe' to work on key technologies. This will help to further bridge the innovation gap between the EU and its major global competitors. The first 'knowledge and innovation communities' should be in place by the end of 2009. The EIT will also be attractive for excellent organisations in your regions: in order to contribute to the Europe's competitiveness and to reinforce the international attractiveness of the European economy, the Institute needs to attract partner organisations, researchers and students from all over the world.

All these instruments are indispensable elements to realise the free circulation of knowledge – the so-called 'Fifth Freedom' – and to reform the research and education landscape. This is prominently reflected in the discussions and proposals to further improve Europe's S&T performance through developing the European Research Area – to which I will turn now.

There is general agreement on the fact that the international impact of national AND Community research and education programmes can significantly be enhanced by working together more closely.

It is true that many good research and education initiatives have been launched at national and international levels but that greater coherence of these initiatives can contribute to a globally competitive, knowledge-based and innovative Europe. The European Research Area (ERA) will contribute to this aim through close coordination or integration of national and Community research activities. In April 2007 the Commission re-launched the debate about further developing the ERA by publishing a Green Paper laying out new perspectives for

European research policies. Core to that process is the willingness of member States, the countries associated to the Research Framework Programme, and the Commission to *share responsibility* for further establishing the ERA.

In that context, the Commission sees the future of research in:

- guaranteeing the free movement of knowledge with attractive career prospects for researchers;
- establishing and promoting modern globally competitive universities and research organisations, able to deliver excellent science and technology;
- creating favourable conditions for all research actors to invest in research and exploit its results;
- having access to world-class research infrastructures and strong cooperation links with partners outside Europe;
- and finally in contributing to solve major societal challenges.

Let me ensure you that the five ERA initiatives the Commission has already proposed or will soon propose are clearly directed towards these objectives.

Already in April, the Commission has put forward Commission's *Recommendations and a Code of Practice on the management of Intellectual Property by public research organisations*.

In May the Commission initiated a *European partnership for researchers* to achieve rapid and measurable progress in making Europe a more attractive place to do research, for example by increasing the number and level of training of researchers or by improving employment and working conditions.

In July the Commission has adopted a *Framework to help member States to develop joint public research programmes* and a proposal for a *Legal Framework for new pan-European Infrastructures*. Both initiatives will help to act together more efficiently in research and to overcome the existing scarcity of resources.

Finally, we are in the process of proposing a *Strategic European Framework for International Science and Technology Cooperation* which will include several key principles to raise the S&T profile of Europe worldwide and put the European Research Area on the global map. The need to further integrate neighbouring countries into the European Research Area is one of those principles.

Actions will be important to demonstrate that the principles are being applied! Their implementation will facilitate access to knowledge and resources worldwide, will have a positive influence on the global science agenda by pooling a critical mass of resources, will improve the framework conditions under which international research is conducted, and will help to build S&T capacities.

I would like to reassure you that alongside these initiatives, the implementation of the *Seventh Framework Programme* continues apace, in particular through new dedicated instruments that foster international cooperation. In particular, the Specific International Cooperation Actions aim to reinforce research capacity in ENP partner countries and to address the particular needs of developing and emerging economies.

Experience shows that in order to strengthen the international impact of research and education programmes and policies a number of measures can be successful, like, for example:

- to open up national programmes to participants from other countries in order to encourage competition with the best talents around the world;
- to set up research funding schemes for cross-border research; other practices could be:
- to reinforce research cooperation activities with third countries to exchange best practices and identify common priorities;
- to give investments in human capital and the free movement of knowledge, researchers and students a high priority;
- to strengthen your research institutions and universities as the major producers of knowledge, suppliers of skilled professionals and researchers;
- and to improve the framework conditions to turn knowledge successfully into commercial applications, for example by improving intellectual property rights or the access to financing.

The Commission is convinced that these are key measures which are needed for more effective research and education, faster knowledge generation and enhanced benefits for all our citizens.

During your reform process you will need to make sure that all of the sides of the knowledge triangle stand together: Excellence in research is impossible without quality in education, and research efforts are wasted if they do not lead to innovations that generate jobs and growth.

Certainly, wider Europe faces common challenges and the Commission is definitely prepared to address these challenges in partnership with you.

Bilateral and Multilateral Cooperation Activities: Key Factors and Synergies

George BONAS
Adviser for S&T, International Centre for Black Sea Studies (ICBSS)

Introduction

Among the key parameters for the development of high quality S&T, international cooperation occupies a prominent place since several decades and can be considered as a *sine qua non* activity in the present and forthcoming years. There are many reasons that contribute to an increased international cooperation in S&T among which we can state:

- the complex and multidisciplinary character of state-of-the art research in most of the fields of science that demands large research teams and expertise not always available in a single country;
- the need to access specific research infrastructure; this does not only concern unique infrastructure as, for example, CERN but also installations such as synchrotrons, high performance spectrometers, etc.

In parallel, international cooperation has been facilitated and stimulated by an increased cross-border communication (*e*-infrastructures such the GEANT high speed research and education electronic network) and an increased mobility of researchers, which includes high education students, PhD candidates, post-docs and permanent research personnel.

At the level of countries, international cooperation is implemented mainly through two relatively distinct activities, i.e. the bilateral and multilateral ones. Key factors for these two types of activities, which should be addressed in a coherent and complementary way by every country, will be analyzed here together with some synergies that could arise among them.

Bilateral cooperation activities

The bilateral cooperation activities are historically the first international cooperation activities that have been developed and continue to play a key role in the S&T systems of the countries. From a legal point of view, usually these activities are covered by an Agreement between the countries, either a specific one for S&T or a broader one covering also other fields of cooperation (economic, cultural, etc.). Even more important is the implementation of the Agreements that often takes the form of Protocols with dedicated budget, duration and procedures, signed between the relevant implementing authorities.

The typical activities supported by the bilateral cooperation programmes include mobility of young and/or experienced researchers, research projects with common goals among teams of the two countries, specific studies, conferences, workshops, etc.

It is obvious that any single country cannot establish and support formal bilateral cooperation activities with all the other countries in the world. Consequently, a selection of the countries with which bilateral cooperation activities will be implemented is necessary. Such selection is often driven by the following considerations:

- the collaboration for broader political reasons; in this case, S&T is often considered as a privileged field since it mobilizes the central administrations and it addresses the elites of the two countries, while, at the same time, it does not demand significant legislative or economic efforts for the implementation of the agreed activities;
- the targeted collaboration for scientific reasons; such collaboration is usually integrated in a broader national policy for scientific and technological development and targets countries with significant potential in a certain field, aiming at a know-how and technology transfer.

Bilateral activities for 'broader political reasons' are often launched in a rather un-structured way, in particular when they are the result of a broader Agreement (e.g. for Economic cooperation) signed on the occasion of a visit to or from a respective country at high governmental level. Such activities often lack an in-depth evaluation of their potential impact and, moreover, of their cost in terms of administrative load and budget.

At the level of every country, some bilateral cooperation schemes have been launched since long, while others are added from time to time, following the aforementioned two 'paths'. In this context it is therefore important for the countries to proceed regularly to evaluations of the impact of their bilateral activities. Such evaluations should provide the necessary evidence for the continuation of the activity, for its re-orientation (other type of activities, other scientific fields, etc.), or even for a possible interruption, despite the political sensitivity for such decision.

The need for a re-consideration of the role and necessity of the bilateral cooperation programmes is particularly evident among the EU member States that currently cooperate intensively under various schemes and activities of the successive Framework Programmes. For these countries, instead of formal exchange programmes or joint research activities, more flexible bilateral activities such as workshops in emerging fields of science or on urgent needs (e.g. bird flu), could be more appropriate. A condition for a rapid and efficient implementation of such activities would be the maintenance of contact persons for bilateral activities in the two respective administrations, even if a formal bilateral cooperation programme is not implemented anymore.

Multilateral cooperation activities

During the last decades, multilateral schemes are gaining an increasing importance, especially in Europe. Among such schemes we can state the COST[1] programme, the successive

[1] COST: European Cooperation in the Field of Scientific and Technical Research (www.cost.esf.org).

Framework Programmes (FPs), EUREKA[2] and others with more regional relevance (e.g. around the Baltic and the Black Seas).

The multilateral schemes are absorbing considerable efforts and human resources, in particular at the level of the research administrations, for the close follow-up of their planning and implementation. It is therefore important for the national policy makers to keep a clear and realistic view of the potential benefits that can arise from the participation in such schemes, in order to better prepare the whole system for a successful involvement of their country in them.

Among the multilateral cooperation schemes, the currently running 7th Framework Programme (FP7) of the EU is by far the most important such scheme at least for the European countries at large. The FP constitutes a real arena for competition among research teams and provides substantial funding for international research activities. Moreover, the FP constitutes a real benchmark of state-of-the art research orientations and the close follow-up of its setting up and implementation can provide a valuable input for the orientation of the national research systems.

However, in terms of funding false expectations should not be raised since the competition is extremely high and consequently the success rates are low even for EU member States and countries Associated to FP7. This is even more a reality for Third countries, despite the declared and agreed openness of FP7 to most of the countries in the world. For the Third countries in addition to the strong competition other considerable obstacles exist, such as the lack of strong links with research teams in EU member States, the lack of know-how in the procedures for participation, the inherent differences in the administration of research contracts in countries outside the EU, etc.

In this respect, the delicate balance between, on one hand, the effort to devote for participation in the FP and even more for an Association to it that also necessitates a substantial financial contribution, and on the other hand, the potential benefits that could arise, should be an issue to consider seriously. However, it must be stated that when assessing the benefits, in addition to the expectations for funding of the research activities, other less tangible but at least equally important benefits should be considered: identification and exchange of best practices, benchmarking activities, stimulation of the research community, etc. When targeting a successful participation to the FP (with or without an Association to it), Third countries should be ready to implement the necessary changes in the national research systems in order to maximize such 'side' benefits.

The participation of countries in other multilateral schemes of more regional relevance such as the BSEC[3] Working Group on S&T or the Steering Platform in S&T for the Western Balkan Countries (WBC) also provides positive effects as the ones mentioned earlier (identification and

[2] EUREKA: pan-European network for market-oriented, industrial R&D (www.eureka.be).

[3] BSEC: Black Sea Economic Cooperation (www.bsec-organization.org).

exchange of best practices, benchmarking or other support activities of horizontal character) that minimize the lack of any (or at least any substantial) funding. Such activities are discussed at the level of regional policy dialogue *fora* that can stimulate the implementation of pertinent initiatives funded by the FP or by bilateral cooperation schemes.

Synergies between bilateral and multilateral activities

These synergies could be two-way and their potential has not been explored significantly. Very often the barriers for the development of such synergies are linked to differences between the involved administrations, and persons responsible for the two schemes at national level, the different programming periods and procedures, etc.

Two possible ways to develop synergies between bilateral and multilateral activities could be the following:

- the use of the dense network and funding of bilateral cooperation schemes (e.g. among the Black Sea counties) in order to develop multilateral cooperation activities; such approach will not necessitate additional funding and new procedures but rather an Agreement and commitment of the participating countries (on a variable geometry basis) to include in their bilateral programmes a jointly agreed activity such as, for example, the mutual access to important research infrastructures;
- the transfer of best practices and benchmarks identified at the level of policy dialogue *fora* to the bilateral cooperation programmes, in order to boost in the involved countries any field lagging behind.

Another important systematic attempt to develop synergies between the bilateral and multilateral activities is the implementation of ERANET type projects e.g. in the WBCs and the Black Sea region, aiming at the development of joint (i.e. multilateral) calls for proposals based on the numerous existing bilateral cooperation programmes.

Conclusion

The active and fruitful engagement of any country in the aforementioned activities (bilateral, multilateral and their synergies) necessitates an in-depth knowledge of the country's capabilities and, moreover, of its strategic objectives. At regular intervals and certainly before any critical step (e.g. establishment of a new bilateral cooperation programme, Association to the FP, etc.) a thorough assessment of the cost/benefit ratio should take place, not only in terms of funds but also in terms of intangible benefits, which should be in line with the national strategic objectives. Such assessments would avoid the initiation or continuation of activities that do not fit to the strategic objectives, leaving the necessary resources available for more pertinent activities.

The Global Research Partnership of K.A.U.S.T.: a Model for Research Universities in the 21st Century

Huntington WILLIAMS, III
Director, The Washington Advisory Group

It is a pleasure for me to be at the Moldova Academy of Sciences for the International Conference on Science and Education Policies. I am here to discuss the Global Research Partnership of KAUST as a model for research universities in the 21st century.

The first question to answer is: What is KAUST?

KAUST, which stands for King Abdullah University of Science and Technology, is a new science and engineering university in Saudi Arabia. KAUST is an independent, merit-based, graduate institution open to talented men and women of all backgrounds and cultures. It is the first truly coeducational institution in Saudi Arabia. KAUST fulfills a 25-year-old dream of King Abdullah to build a world-class research university in his country. The initial endowment is $10 billion. The campus, including world-class laboratories, is currently being built on the coast of the Red Sea north of Jeddah at an additional cost of $3 billion. KAUST is a private university, is self-governing, and has an independent Board of Trustees. There has been nothing like it in the world of higher education since Leland Stanford gave the land and endowed Stanford University in the late 19th century.

The second question to answer is: What is the Global Research Partnership (GRP)?

The GRP is the extramural funding programme of KAUST. Unlike in the U.S. and other countries, there is no National Science Foundation or National Research Council in Saudi Arabia. Consequently, KAUST funds as well as conducts research. As a first step to developing the research on the campus, KAUST is funding scientists and engineers at other leading universities in research areas that are important to Saudi Arabia, the Middle East region, and the world.

By way of introduction, the last question to answer is: What is the role of the Washington Advisory Group (WAG)?

WAG is the academic and research development consultant to KAUST. We helped develop the organizational model for the university and are managing the initial rounds of the GRP. A seven-member core team of WAG consultants is working on behalf of KAUST, including Dr. Frank Press, the former president of the U.S. National Academy of Sciences, who is the senior scientific adviser to KAUST; and Tom Owens, the founding president of the Civilian Research and Development Foundation, who is the senior advisor to the GRP.

Saudi Arabia faces a number of challenges in its ambition to create a world-class university. King Abdullah is 83 years old and, not surprisingly, wants KAUST to succeed quickly. Its goal is to join the ranks of top-ranked universities in 20 years or less. The intellectual infrastructure to realize this ambition is not yet in place, however. According to *Nature* (Vol. 444, Issue no. 7115, 2 November 2006), Saudi Arabia spends less than 0.25% of GDP (Gross Domestic Product) on science and technology. The Kingdom and the Middle East have talented people, but weak educational institutions. A diaspora of distinguished Arab scientists and engineers is working and living abroad, but few world-class scientists reside at universities in Saudi Arabia and elsewhere in the region. In short, KAUST has money, but this is a necessary, not sufficient, condition. Even with a strong intellectual infrastructure and unlimited resources in the Kingdom, it would be a huge challenge to build a world-class research university from scratch in such a short period of time.

KAUST, on the other hand, is unconstrained by traditional university models. Most of the world's leading universities were founded as undergraduate institutions and are organized around Schools and Departments. They have their roots in 19th century disciplines, which are static and organizationally embedded. KAUST is a graduate university with Master's and Ph.D. programmes only. Its research and academic programmes can be much more nimble, and are organized around interdisciplinary Centers and Divisions.

Early on, KAUST decided that, to become a world-class university, it needed to engage with other world-class universities; and the Global Research Partnership is one of three strategies designed to do just that. Let me briefly describe the other two. The first is a '*Special Partner' Strategy* that uses targeted Memoranda of Understanding to help develop the on-campus research laboratories. KAUST has signed agreements, for example, with the Woods Hole Oceanographic Institution to develop an international field station for Red Sea biosciences research; and with the Institut Francais du Pétrole to develop the research programme in clean combustion.

The second is the *Academic Excellence Alliance* programme. Here the university's partners are helping to develop the KAUST curriculum and recruit the founding faculty. KAUST has signed agreements, for example, with Stanford University in the field of computer science; UC-Berkeley in mechanical engineering; UT-Austin in earth sciences and engineering; Cambridge University in biosciences and bioengineering; and Imperial College in materials science and in chemical engineering.

The GRP, the third strategy, is helping KAUST establish a global 'footprint' in its selected areas of research interest by funding world-class scientists and engineers at other leading institutions around the world.

KAUST used a structured solicitation process for GRP proposals in Round One of the program. Sixty institutions, carefully selected for research strength and international balance, were invited to nominate researchers and submit proposals. This process limited the number of participants but enabled the programme to start quickly.

The GRP offered three streams of funding:

- Centers: large, multi-disciplinary research groups with funding of up to $5 million per year for five years, similar to U.S. National Science Foundation Engineering Research Centers

awards. Center-in-development awards offered funding of up to $1.5 million per year for three years.
- Investigators: small group research led by highly accomplished and promising individual scientists, with funding of up to $2 million per year for five years; similar in scope and intent to the Howard Hughes (HHMI) Investigators programme.
- Research Fellows: – post-doctoral researcher support, with funding of up to $100,000 per year for three years.

In addition to intrinsic scientific merit, the request for proposals explicitly asked for ideas about how the proposed research could contribute to the development of on-campus research at KAUST.

Forty-seven of the 60 institutions responded in Round One, and 34 Center and Center-in-Development proposals, 66 Investigator proposals, and 63 Research Fellow nominations were received.

KAUST used review panels to judge the scientific and technical merit, and world-class scientists evaluated and ranked the proposals. The Center review panel, for example, included Prof. Ion Tighineanu, the Vice President of the Moldova Academy of Sciences. A rated and ranked list was provided to the leadership of KAUST, and the final award decision was made by the KAUST Board of Trustees.

In Round One total funding of more than $200 million was committed to four Centers and three Centers-in-Development, 12 Investigators, and 19 Research Fellow Center awards were made to Cornell University: KAUST-Cornell Center for Research and Education (novel hybrid nano-materials), Oxford University: Oxford Centre for Collaborative Applied Mathematics, Stanford University: Center for Advanced Molecular Photovoltaics, Texas A&M University: Institute for Applied Mathematics and Computational Science.

Center-in-Development awards were made to:
- National Taiwan University: Solar Energy Research Center, Utrecht University: Center for Soil, Water and Coastal Resources, King Fahd University of Petroleum and Minerals (KFUPM): Transformative Research in Petrochemicals and Polymers

Investigator awards were made to:
- Bengt Nordén, Chalmers University of Technology: *Bio-inspired molecular nanotechnology,* Edward Hartley Sargent, University of Toronto: *Nanotechnology for solar energy*, Paulo Monteiro, University of California, Berkeley: *Environmentally sustainable 'green' concrete*, Nicholas Paul Harberd, Oxford University, UK: *Salt-tolerant crop-plant genomics*, Yi Cui, Stanford University, USA: *Electrical energy storage using nanowires*, Brian Stoltz, California Institute of Technology: *Aerobic catalytic oxidation chemistry*, William J. Koros, Georgia Institute of Technology: *Membranes in hydrocarbon utilization*, Anna Tramontano, La Sapienza University, Rome: *Computational molecular biology*, Ahmed F. Ghoniem, Massachusetts Institute of Technology: *Energy conversion systems*, Bruce Logan, Pennsylvania State University: *Energy-sustainable water treatment and infrastructure*, Peter A. Markowich, Cambridge

University: *Applied and computational differential equation*s, Nobuyasu Ito, University of Tokyo: *Computational nanodynamics.*

What are the initial outcomes of the Global Research Partnership, and what are the lessons learned for KAUST?

For KAUST, the important outcome is that the University is 'on the map' in its research focus areas even before the campus opens. The founding President and Provost of the university were hired in early 2008, and the faculty and on-campus Center Directors are currently being recruited. KAUST is scheduled to open in September 2009.

Thanks to the GRP, relationships with world-class scientists and engineers at leading universities around the world are already in place while the campus is being built. The longer-term payoff will be even greater. All GRP-funded research is conducted at the home institutions of the awardees, but each Investigator has committed to spend at least three weeks per year in Saudi Arabia once the campus opens — giving lectures, providing research updates, and interacting with students and faculty. The Center and Investigator awardees have also made more than 400 specific offers of assistance to the development of teaching and research on the campus. This assistance will be invaluable to KAUST in the future. The Research Fellows, for example, who are just starting their academic careers, represent a pool of potential junior faculty for KAUST.

In terms of lessons learned for other universities, the value of the GRP is not a direct role model. The GRP is a big-budget programme designed to help KAUST open with a '*big bang*'. I do not recommend that other universities try to emulate or replicate it. Money, like oil, is a scarce resource and even if cost were no object, there are better ways for existing institutions to spend their resources.

However, GRP offers a number of valuable lessons for any region or country that is seeking to upgrade or enhance its research profile. These key lessons include:

- *Focus and Aim High*. Decide what is most important to your institution, country or region, and then plan your R&D strategy to be world class in key relevant fields.
- *Partner aggressively and strategically*. The global research community has fewer and fewer institutional and international boundaries. No one can be great in every field.
- *Leverage your assets in collaborations*. Assets are more than money – they can include, for example, unique intellectual talents, social environments, or natural resources.
- *Look beyond the U.S. and European Union.* Huge investments are being made in the Middle East and elsewhere to develop the educational and research infrastructure. Be aware of what is going on globally in your field of interest.
- *Don't expect the world to come to you*. *Sell yourself.* In future rounds, some parts of the GRP may be open competitions, not invitation and nomination only.

For more information about the GRP program, please see:
http://www.kaust.edu.sa/research/global-partnership.aspx.
For more information about the Washington Advisory Group, please see:
www.theadvisorygroup.com.

Some Important Questions Concerning the Development of Research and Education in Serbia

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Transition has created deep social and economic changes in Serbia which was particularly reflected in science as the most sensitive system to changes. Transition from institutional to project funding, low investment in science of only 0.4% of GDP, complicated administration of projects, competition with much stronger players for international project application, all together brought a deep depression and discontinuity in the scientific research resulting in significant 'brain drain'. Compared to other East-European countries which suffer from similar changes, this phenomenon was much more pronounced in Serbia because of the consequences of sanctions, isolation and the war. Before 90's we had very good collaboration with western countries. We had American-Yugoslav and European joint projects for years and were very good partners and collaborators with colleagues from western countries. However, during the embargo, collaboration was cut instantly and after that, there was a large gap in progress of more than ten years. Now, we are not as good partners as we used to be and we must make a great effort to improve international collaboration since it is the only way to have successful research and development. I emphasize this in order to say that politics has a big impact on science, and not only on science.

Today, Serbia is on a good way to recovery which is manifested especially in the Province of Vojvodina which is the most developed part of the country. Here, for instance, the investment in science has increased nine times since 2004. We are not isolated anymore and we are heading to the integration with European community. Today, Serbian Academy of Science and Arts (SASA) maintains relationship with almost all European Academies, it is a member of ALLEA and performs over 50 bilateral projects. Collaboration with Academies of neighboring countries is of particular interest for SASA. Also, in 2006 Serbia achieved a very good result in the FP6 programme for Western Balkan Countries: 16 out of the 30 projects involved in fact Serbian institutions. Therefore, the competition for FP application has significantly increased and became more and more successful. Following the signature of a Memorandum of Understanding with the European Commission, the Republic of Serbia joined the Seven Framework Programme (FP7) in 2007, and is eligible to compete on an equal basis with EU member States in FP7. Since the project application procedure to the FP7 created a large and demanding administrative process, the Ministry of Science and the Academy created a specialized office with the objective to help researchers in applying to FP7.

A rather large amount of equipment has been provided during 2006/2007 from the National Investment Plan Fund. Furthermore, the programme '*Young Researchers on the Road to European Investigations*' is in the process of realization and there is a continuation of co-financing projects of inter-regional and international cooperation.

Each year the State of Serbia allocates 500 'stipends' (grants) to young talented researchers that allows them to study in EU countries. Therefore, there are some optimistic indicators of progress. However, there are still a lot of problems and dilemmas concerning the strategy of research and higher education in Serbia. We try to reach the same goals in European science as EU member States and these are:

- to establish centers of excellence;
- to join international networks according to the European Union's research policy;
- to establish joint research schools and organize research training courses;
- to improve the access and sharing of the European research infrastructures, especially with neighboring countries in order to reduce gaps between regions;
- to focus on applied science and cooperation between science and industry;
- to support innovation projects which create economic extra value;
- and to foster Bologna process in higher education.

These goals, I think, are common for all present Academies and there is nothing new and special about that. However, possibilities to achieve these goals are very different and I would like to make a few remarks on this regard.

Brain drain. – This is certainly one of the most difficult problems in Serbia. There are more than 300,000 young educated people who left the country in the last ten years and this process is continuing. This is the best indicator of a deep depression in science and economy. Each 3rd graduate student from the Departments of Electrical Engineering leaves the country. There are many reasons for such a situation but I shall stress a few of them:

- lack of finances, an inadequate research infrastructure, inappropriate institutional system, fragmented research, and not less important, an uninspiring research environment and still bureaucratic governing science institutions. This is because directors are, in many cases, still selected on the basis of loyalty to the political parties which are in power. They do not need talented young men. They need loyalty.

Therefore, if we talk about 'stemming' and about 'reversing' brain drain we should know that this will not be successful until we change the situation which forced them to leave the country. I am not going to talk about how we can improve this situation but I shall point out just a few things:

- We should support researchers at the beginning of their career to establish their own research team by encouraging research projects of independent talented research leaders.
- Although financial facilities are very important, a good scientific environment, freedom, better organized research and recognition and support of excellence are crucial to keep young scientists at home. We should not treat excellence with mediocrity. We should boost excellences by investing in the best researchers.
- Also, competition on the basis of scientific excellence should be the sole criterion. To achieve this goal, international cooperation, which is important for all countries, is essential for Serbia. At this moment it is very important for us to apply not only for FP projects but also for Structural Funds projects which are 'solidarity instruments' to remove regional imbalances in research, training facilities and infrastructure. Thanks to international cooperation our Institute of Physics in Belgrade, for instance, made an important contribution in building the Big Collider at CERN in Switzerland which will be activated in October this year.

Applied Science. – Now let me say a few words concerning strong promotion of so called applied science. First of all, it is not very clear what 'applied science' means. According to Nobel Prize winner Christian de Duve 'there is only one science: basic science and its application'. For some scientists, the terminology *basic* vs. *applied* research or *science* vs. *technology* is no longer appropriate. Instead they suggest *frontier* science. Other scientists, like L. Wolpert, make clear difference between science and technology and emphasize that this is very important especially from an ethical point of view because basic science produces knowledge which is value free. Only application of knowledge in technology creates ethical problems.

However, Europe is striving to become the world's most competitive knowledge-based economy since USA and Japan transfer much more efficiently than Europe scientific knowledge into industrial applications. But one thing is sure. The application of scientific discoveries is several orders of magnitude more expensive than basic science where brain and ideas are the most important things. In this context, what are the chances for applied science in a small country with poor economy? In order to ensure the transfer of knowledge into technology we must have, first of all, good, healthy science system but there is no healthy science system in a sick economy. Usually, in spite of these arguments, in the first speech of a new minister for science and technology, science transfer into industrial application in order to create high economic surplus value is exaggerated. But in order to 'apply' science one must 'have' science. We neglect the importance of basic science for keeping a high level of education at universities. Here, a new paradigm for academics in science is not 'to publish' or 'to perish', but 'to innovate' or 'to perish'. One of the main goals of the Bologna process is to make education more pragmatic which is all right. But there is a strong tendency for commercialization of academic research. Therefore, we should have more understanding for basic science which will be, perhaps, more productive in small countries until they build healthy and good economy. We could do applied science only through very tight collaboration with wealthy countries.

Conclusion

There is only one way to stimulate progress in Serbian science: to accept the standards and the policy of the European Union in science and to foster international cooperation and competition.

Higher Education and Scientific Research Policy in Bosnia and Herzegovina

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1. Education in Bosnia and Herzegovina

In order to understand the educational system(s) of Bosnia and Herzegovina (BiH) it is important to underline that, according to the Dayton Peace Agreement, Bosnia and Herzegovina is divided into two administrative entities[4]:

- Federation of Bosnia and Herzegovina (FBiH 51%) and
- Republika Srpska (RS 49%).

This is clearly illustrated in the map depicting the predominant population of the country, with the IEBL being the Inter-Entity Border Line within the country, as seen below in Figure 1.

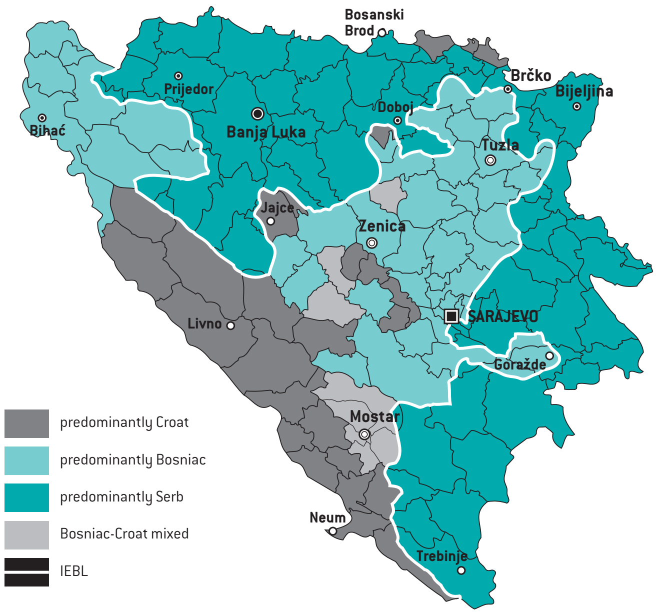

Figure 1: Map of Bosnia and Herzegovina with two entities and predominant population

The Federation of Bosnia and Herzegovina has been decentralized as it is further administratively divided into 10 Cantons, each made up of a number of municipalities, with administrative and governmental units at the cantonal and municipal levels. Republika Srpska (RS), although administratively divided into seven regions, has maintained centralized governance over education. The territory of Brcko, which was under arbitration, became a separate district in Bosnia and

[4] http://www.oscebih.org/overview/gfap/eng/annex4.asp

Herzegovina, and stands out from the rest of the country that is marked by separate educational systems according to the entities and national criteria. Education in Brcko is developed based on a multi-cultural curriculum and within a unique educational system for all those attending it.

1.1 Diversity and fragmentation of education in Bosnia and Herzegovina

As a result of the administrative and political separation Bosnia and Herzegovina has a very complex school system. It is an asymmetric and 'astigmatic' system, presented as an excellent base for reform by the Organization for Security and Co-operation in Europe (OSCE) in one of its documents entitled 'Reform Strategy in Education of BiH'[5] signed by all entity and cantonal ministries in November 2002. However, this Strategy has not been implemented, there is no unified educational policy, the unique values are not nurtured, nor are the common educational goals being set and worked towards. The situation in BiH education in general influences directly and strongly, and has a direct impact on the higher education system in the country as well. The complex inter-institutional links are shown in the diagram below (see Figure 2).

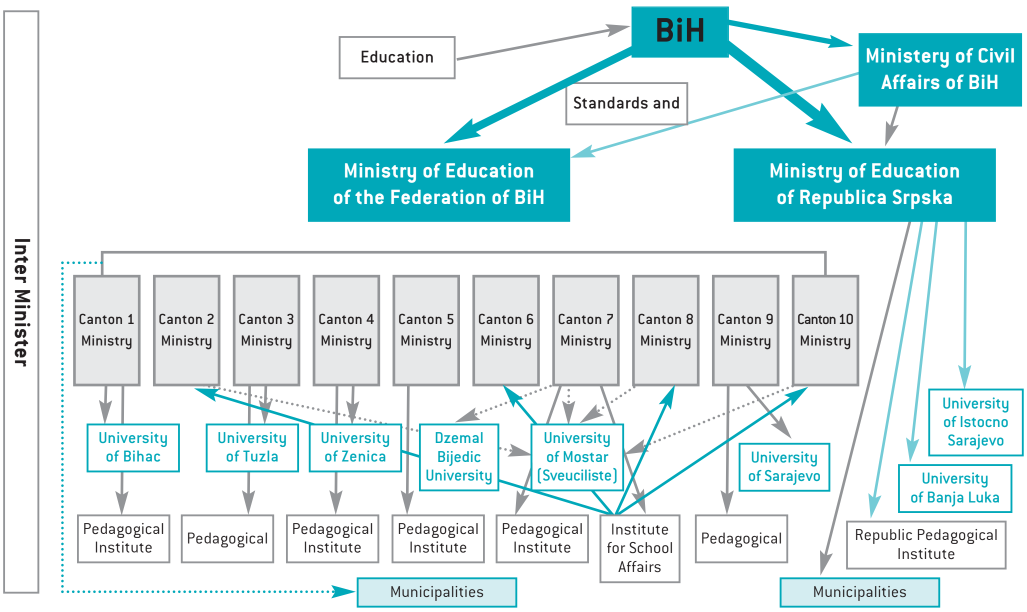

Figure 2: Structure of the Education System in BiH

2. Higher Education in Bosnia and Herzegovina

According to the 2008 official statistics[6], Bosnia and Herzegovina has eight public universities (six in FBiH and two in RS), structured in 136 Faculties (before the war of 1992-1995 BiH had four public universities in Sarajevo, Banja Luka, Tuzla and Mostar).

[5] http://www.oscebih.org/education/?d=2

[6] Agency for Statistic of Bosnia and Herzegovina, Sarajevo, 2008, or http://www.bhas.ba/new/.

Approximately 101.200 students are currently attending higher education programmes in BiH (68.200 in FBiH + 33.000 in RS) taught by 5.620 professors, lecturers and other teaching staff (3.018 in FBiH + 2.600 in RS). Furthermore, if we add all other staff and workers in higher education, these numbers go up to 9.000. This means that the Universities in BiH currently include (whether it is staff, teachers or students) some 110.000 BiH citizens.

Out of 1,000 citizens, some 25.9 are students, and if we add to those professors, lecturers, advisors, and other staff in higher education some 28,2 out of one thousand citizens are involved in one way or another with the higher education process. 12% of BiH population has a tertiary level diploma (8% in two and three-year duration and 4% in four year duration). In FBiH, from the beginning of 2004 until the first half of 2008, some 1,046 students have received their Masters' diplomas, while 337 received their PhD degrees.[7] Statistics of RS do not provide analogue information.

Before the war (1992-1995) BiH was one of the republics the Socialistic Federal Republic of Yugoslavia and had designated 1, 5% of GDP for science and research. Currently, the amount of these funds is less than 0, 1%. At the same time, education in BiH is being provided with similar funds as those prior to the war, which are some 5, 5% - 6% of the GDP and are above regional average.

Contemporary higher education and the status of science in BiH have been shaped by a number of important conditions:

- division of the country into two entities, in accordance with the Dayton Peace Agreement;
- decentralization and cantonalization of education;
- higher number of public and private universities;
- hindered legislation related to higher education;
- expensive administrative-management system of higher education;
- lack of financial support for higher education and science/research;
- slow rehabilitation of commerce and production that was one of the major supporters of research and development.

As a result of all these circumstances, universities are at present a very poor environment for conducting scientific and research work. There are simply no resources, educated staff and no time and space for it. As a result the majority of professors and teaching assistants have no financial support or time to develop research projects. At the same time, universities are being re-organized according to the Bologna Process, which has proven to be very time-consuming for the professors, teaching assistants and all staff that works with students on issues of curricula and higher education. Such a situation allows for being guided and directed by subjective reasoning, and entrusting professors, which currently are more of compilers rather than researchers. In such a situation the risk is that universities become schools, rather than institutions that unite studying and experiences in scientific research and development.

[7] http://www.fzs.ba/Podaci/Federacijaubrojkama2008.pdf.

2.1 Reform of higher education according to the Bologna process

Starting with the 2005/6 school year, all of the public universities in BiH have started to implement the first cycle, according to the principles of the Bologna Process. Teaching curricula have been reformed and have been adapted to students attending universities in two cycles. The models most frequently used included: the 3+2 model or the 4+1 model, depending on the university, or the group of studies to which the given model applied. The European Credit Transfer and Accumulation System (ECTS) has been introduced for all of the new study programmes, while the universities prepared to issue an addition to the diploma given to the graduates that will be schooled in accordance with the Bologna Process. In June 2008 the first cycle of studies according to the Bologna Process has been completed and the first generation of students has graduated obtaining Bachelor of Science degrees.

Greatest and most significant assistance to BiH in this reform process was provided by the Council of Europe, European Commission in BiH and the Austrian Development Agency.

The strategic orientation of BiH, as set forth in the document '*Strategic Directions of Development of Education in Bosnia and Herzegovina for the Period of 2008-2015'*, stated that by the year 2015, educational system of BiH will be included in the European Higher Education Area (EHEA). This means that the student enrollment rate will have to increase from 22% to 32%, and that the funds allocated for research and development and international educational and scientific cooperation and exchange would also have to be increased. These strategic directions may prove to be difficult to meet, as BiH would first need to significantly increase financial investments into universities, as it already lags behind the other universities in the region of the former Yugoslavia (Zagreb, Belgrade and Ljubljana) according to the costs associated with one student, as shown in the bar chart in Figure 3 (see below):

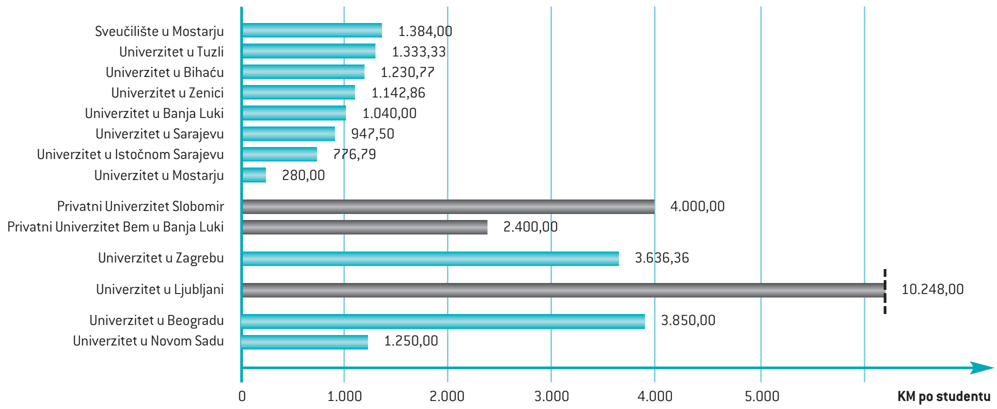

Figure 3: Annual cost of studies (in BiH national currency, BAM) per student for public and private universities (by name) in BiH and other countries of former Yugoslavia

According to Figure 3 presented in a recent report of the EU Commission on education in BiH, the 'cost' of one student's school-year varies between approximately 280 BAM (140 EUR) – the lowest value at one of the University of Mostar, and 1355 BAM (680 EUR) – the highest value at the second University of Mostar that uses the Croatian study programme.

3. Steps Currently implemented by BiH aimed at improving the Status of Higher Education and Scientific Research

In spite of the very difficult situation and numerous challenges and issues that the education of BiH is facing, there are a number of efforts, especially in the few recent years that have been made to improve this situation. The most important steps taken focused on setting legislative standards and on adopting the necessary documents at the level of the entire country that reflect the most important directions for further development of scientific research and higher education. Below are listed some of these steps:

- the Academy of Sciences and Arts of BiH in 2006 delivered the *Strategy of Scientific and Technological Development of Bosnia and Herzegovina*. From the second half of 2007 the Federal Ministry of Education and Science formed a Science Council which has been active in assisting the Ministry in the definition of priorities related to science, the choice of research projects to be financed, and the overall contribution to the development of national research. This Council is made up of recognized members of the Academy and professors from all of the universities within FBiH. One of the results of the on-going reform is the increased awareness on higher education and research as generators and basis of socio-economic development in Bosnia and Herzegovina;
- in June 2007 the Framework Law on Higher Education has been approved, following a four-year preparation and debates. This Law will enable to reach the pre-requisites and facilitate the accession into the European Higher Education Area (EHEA);
- at the beginning of 2008, the document '*Strategic Directions of Development of Education in Bosnia and Herzegovina for the Period of 2008-2015*' has been adopted. It includes measures aimed at strengthening the links between higher education and scientific research, developing an institutionalized network for research and development throughout the higher education institutions of BiH, ensuring modern infrastructure and equipment, reconstructing and rejuvenating the teaching staff;
- in June 2008, Bosnia and Herzegovina hosted in Sarajevo the meeting of the Group for Monitoring the Implementation of the Bologna Process, an international group of representatives of Ministries of Education from all 46 countries included in the Bologna Process, including representatives of European associations of students, professors, universities and employers. The fact that this has been the first meeting of this Group to be held outside the EU borders, since the signing of the Bologna Declaration in 1999 says a lot about the progress of the educational sector in Bosnia and Herzegovina;
- two Congresses have been held with the scientists of the BiH Diaspora (2006 and 2008) in an attempt to establish closer cooperation links between BiH scientists from the country and abroad, in order to form a bridge for all future international research cooperation.

4. Financing higher education and scientific research

Development of the scientific and technological potential of BiH is based on the recommendations of UNESCO through three framework goals: training of a new generation of scientists at the universities within BiH or abroad; develop research infrastructure according to international standards and reinvestment into industrial research in selected sectors.

According to all indicators, BiH is currently spending approximately 0,1% of its GDP[8] on research, while the goald is to reach the EU standard set in the Lisbon Strategy from 2000. The distribution of funds for research is handled separately by each institution, with the funds increasing each year both at national level, throughout the entire Federation of BiH and in the administrative cantons. Certain funds are allocated in the institutional budgets for support to innovators.

Funds are allocated in order to support the professional development of scientific and university staff, through co-funding of post-graduate or doctoral education, encouraging young experts to participate in research, scientific gatherings, professional development programs abroad, to assist in publishing scientific literature and higher education textbooks or scientific journals, and to organize scientific gatherings. The entity Ministries have already started the process aimed at revitalization of the academic and research network in Bosnia and Herzegovina.

For example, the Federal Ministry of Education and Science has, in 2007, supported and financed the thesis of approximately 211 young PhD candidates and of other 207 Master students enrolled in scientific programmes; furthermore, it assigned co-financing tuition grants to 131 talented undergraduates and to other 220 post-graduate students. The Library Catalogues are now much richer, as more than 2.500 volumes, with over 65 significant titles were purchased (university, scientific and professional literature), 53 scientific and higher education institutions have now new equipment, 25 scientific-reference and other professional journals; 21 international scientific gatherings received co-financing grants in the entire Federation of BiH. Furthermore, 47 projects from various scientific branches[9] received financial support while other 125 research projects were assigned co-financing 'travel grants' for participation in international congresses outside BiH.

Funds allocated to support higher education and research in 2008 have increased in FBiH by approximately 50% compared to the previous year, and an increase in users of these funds can be expected towards the end of this year.

Science and technology funds have been increased in RS as well: according to the latest statistics, about 6,4 million BAM have been allocated for the development of these fields, that is 30 % more as compared with the past year and 70% more than the amount allocated in 2006. This, however, amounts solely to 0.86% of the GDP in RS, while, as stated earlier, prior to 1991 BiH allocated 1,5% of its GDP to these purposes. According to the Minister of Science and Technology, RS does not lag behind the countries in the region, as the contributions to science are being increased each year, even if these values are some five hundred times less than those in the developed countries of Europe, and at least a thousand times less than the values in USA and Japan[10].

[8] GDP estimation 2008 is US$ 43.000 billion, per Capita US$ 10.70.

[9] Federal Ministry of Education and Science: http://www.fmon.gov.ba/index.php.

[10] Ministry of Education and Culture and Ministry of Science and Technology of Republica Srpska: http://www.vladars.net/sr-sp-latn/Vlada/Ministarstva/mnk/Pages/Splash.aspx

5. BiH participation in international research projects

The long-term aim of BiH is to further develop scientific and innovative activities that have been presented in the Action Plan of the EC supporting the Lisbon Strategy.

The 2008 visit to BiH of the European Commissioner for Research, Mr. J. Potočnik, and the generous offer that the 'ticket', or the granted access to the framework programmes of the EU can be financed from the Accession Funds, has convinced the Council of Ministers of BiH to show growing interest for full-fledged membership and participation in the 7th Framework Program – better known as FP 7. Until then, Bosnia and Herzegovina was participating in the FP7 as a third country partner. Compared to the previous year there is a slight improvement in the success of cooperation with EU partners under FP7.

Other numerous incentives have been supported, including the Steering Platform for Research in the Western Balkan Countries, SEE-ERA.NET, and WBC-INCO.NET (Western Balkan Countries INCO.NET), along with the accession of BiH to the scientific cooperation funds of EUREKA and COST.

The Strategy for the Development of Science, which is currently prepared, should identify the current scientific potential of BiH and define the priority scientific areas that need support and investments in the near future. BiH's participation in the EU programme FP7 along with other international initiatives, represent a step closer to meeting this aim. In addition to the activities mentioned, it is necessary to significantly increase financial contributions made towards scientific development, in order to achieve the allocated funds that were available in the early 1990s.

Creativity, self-initiative, individuality but also successful cooperation cannot be developed by students, the future experts of the country, if their acquired knowledge is based solely on learning and accepting unfamiliar content. The student must learn how to draw on the knowledge from the world that surrounds them and also from the so-called 'unknown' sources, but needs to be guided in this process by the teacher experienced in the scientific research. This component of teaching in higher education, with very few exceptions, is mostly ignored, or completely pushed to the margin in the higher education of Bosnia and Herzegovina today.

In conclusion, two of the most significant priorities should be pointed out:

- Improved quality of higher education in BiH, including an increased number of scientific research activities supported with adequate financial resources, and
- Increased percentage of population in higher education and participation of BiH universities in the network of European higher education institutions.

Estonian Higher Education and Research and Development (R&D) Policy, 1988-2008

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Estonia has gained considerable success in high level targeted research and avoided some of the pitfalls of the liberal market approach to tertiary education while preserving Estonian as the main language of instruction and the full spectrum of tertiary education.

Four periods outlined below follow the OECD 2008 review (www.oecd.org\edu\tertiary\review):

- 1988-1995: diversification of HE providers, merger of research institutions with universities, breakaway from Russian/Soviet schemes. Broad initial regulations by 1995/96. Substantial autonomy to the public TEIs. Turn to the Western paradigms in social sciences. Cut off from funding for (military) R&D. Experienced researchers employed abroad. Low-cost subcontracting. Important donors: EU TEMPUS, Georg Soros Foundation, Nordic countries, UK and US.
- 1996-1999: 'Intermediate' degree reform: 4-or 5-year Bachelor; 2-year research-Master (limited number of positions); 4+ year PhD, no more habilitated doctorate. Working age census of 65 for academic staff in national university. Competitive funding of research (no exceptions). Setup of regular international evaluation of study programmes (HEQA) and accreditation of research teams (failure: no State recognition a/o funding). Regional marketing of TE. Universal secondary graduation exam becomes the major access qualifier. Research administration from AofS to the Ministry. Public universities admit fee-paying students, providing for the expansion of enrolment: 2,5 times more students study in 2005 than in 1995. Importance of donors continues.
- 2000-2004: fast adoption of Bologna framework; quality based baseline research funding added on top of the competitive schemes; graduate schools, centres of excellence and competence; curriculum development programmes; 2nd wave of accreditation and evaluation; setup of professional TEIs; 1st wave of improvements of student housing (dormitories); quality agreement between universities. EU access programmes gain importance, overall role of donors decreases.
- From 2005: investments into research and study buildings and dormitories, equipment and curriculum development. Support to innovation, English-language master programmes, Estonian-language terminology and textbooks. Applied research programmes in various branches. Mobility schemes to ensure two-way traffic. Mergers and crossing the institutional barriers. Equity issues considered. Donors support to TE in some EHEA countries; founding of EQAR.

Losses: some generations underrepresented in academy; some social scientists did not reorient mentally and linguistically.

Challenges: most listed by OECD; those related to the survival of small-language culture. Research competitiveness of some practice-centred TE areas.

Strengthening the International Impact of National Science and Education Programmes in the United States: Innovation, Entrepreneurship and Partnerships

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In our global economy, knowledge and innovative ideas can emerge from any region of the world, travel in a flash, cross the planet to the most distal sites where interpretation, application and contextualization occurs. I'd like to set my comments in context of the goals and mission of my agency, the National Science Foundation (NSF) of the United States of America and especially the division I work in which is responsible for science, engineering, technology and mathematics (STEM) education for both the STEM workforce and for an engaged informed citizenry. The National Science Foundation Act of 1950 set forth NSF's mission and purpose:

To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense.

The Act authorized and directed NSF to initiate and support:

- basic scientific research and research fundamental to the engineering process,
- programmes to strengthen scientific and engineering research potential,
- science and engineering education programmes at all levels and in all the various fields of science and engineering,
- programmes that provide a source of information for policy formulation,
- and other activities to promote these ends.

Over the years, NSF's statutory authority has been modified in a number of significant ways. In 1968, authority to support applied research was added to the Organic Act. In 1980, The Science and Engineering Equal Opportunities Act gave NSF standing authority to support activities to improve the participation of women and minorities in science and engineering. Another major change occurred in 1986, when engineering was accorded equal status with science in the Organic Act.

NSF has always dedicated itself to providing the leadership and vision needed to keep the words and ideas embedded in its mission statement fresh and up-to-date. Even in today's rapidly changing environment, NSF's core purpose resonates clearly in everything it does: promoting achievement and progress in science and engineering and enhancing the potential for research and education to contribute to the Nation.

Now, at a time of global economic interdependence with scientists working across borders to solve problems of great complexity, NSF is looked to by the country and to a degree the world to take a leadership role in developing the future scientific innovators.

The world is flat BUT this doesn't mean we look at information in the same way when it comes to problem solving, experimentation and interpretation of meaning. We have different experiences, different cultures within our sciences and different histories which contextualizing our understanding. In fact, we might use information differently missing some of the most salient ideas that can emerge from a more diverse international perspective.

We have, as most of us can agree, moved out from the mindset of the industrial age, thought the information age and are in the midst of the knowledge age... an age of innovation. How do we maximize what each of us has to offer to strengthen the impact of successful national programmes to benefit our global society? Where do we find the niche areas where we can contribute most effectively? What are our best practices for impact and strengthening our programmes with new ways of knowing? Together we can have the most striking impact by working together to create an innovative environment.

Innovation serves as the centerpiece for the NSF goal on Learning. The goal of learning commits the Foundation to cultivate a world class, broadly inclusive science and engineering workforce and the expansion of the scientific literacy for all citizens, no matter where they live. The experience of the US indicates that when universities and institutes with diverse and 'collaborate teams' (true partners) partner they produce new inventions, ideas and innovations very year. The basic idea is that:

Education Spurs Research. Research and Development spurs the Economy.

Together, we must be that catalytic force which creates the partnerships, networks, and removes the barriers to create global partnerships. At NSF we recognized that partnerships not only speed the transformation of knowlwdeg to application but also advance discovery, innovation and education beyond the frontiers by the addition of the international perspectives. Partnerships are increasingly becoming a means of information transfer which can leverage what is known on a local scale to the interpretation and modification of the international community and by doing so strengthening the original ideas.

At the National Science Foundation we have several successful models of programmes working towards solving problems of global importance where research and education work hand and hand to support a robust and healthy science community.

I believe the skills of innovators and inventors are what will be needed for the Knowledge age. No longer will educational environments which rely solely on an apprenticeship (copying) model of learning or classes which are predominately lecture based with passive memorization support knowledge creation. As a scientist and science policy educator, I believe that the more our students are exposed to numerous and diverse research environments, the more they cultivate their interests, their curiosity as the whole context allows them to think creatively about problems worth solving.

Innovations are not dependant on any one factor but a confluence of multiple factors, inside and out of academics, institutes. Engagement often takes place within formal and informal education settings boosting the creative aspects of discovery which rests within the unusual application of an unexpected tradition to solve an important – relevant problem. This can excite students, engage students, and this retains students in the scientific enterprise. Inquiry into matters that are of importance to them as practiced by the scientist they hope to become.

Our responsibility lies in creating the environments where the confluence of multiple factors can co-exist and it's also our responsibility to decrease and eliminate the barrier to this.

How do we do this? Quickly let me rattle off a few ideas:
- What if we rewarded wrong- but interesting solutions?
- Learning by stretching ones limits, retrying, altering? Brainstorming?
- Learning by questioning authority;
- Learning by imagining dreaming of what solutions might look like;
- Learning by improvisation – yes let students pretend;
- Learning by creating;
- Let us imagine: What would happen to our future generations of scientist and engineers if they practice these skills?

One of the most important elements to help uncover the scientist they are is the ability to solve problems in diverse teams – collaborative teams. Within these teams international collaborators can find themselves unburdened by the traditional solutions bringing those unusual applications to unexpected traditions.

To maximize chances of creativity and innovation our partnerships – collaborative teams are intentionally developed. Each member of the team has a role and is interdependent on each other for a diverse range of knowledge and skills. I offer a few guiding principles for these international partnerships.

1. Partnerships are designed to allow students to participate with faculty and the business community to collectively build knowledge the way professional communities, science laboratories, and business teams collaboratively innovate.

2. Partnerships allow students to engage in the inquiry process of identifying the driving question to guide the 'classroom' activities and then hypothesize possibilities, marshalling evidence in support and against competing hypotheses. At the same time, we need to make room for creative inspiration, connecting ideas and application which may manifest itself by resting outside the classroom in the informal educational environments.

3. Successful innovative environments allow students to engage in productive argument because evidence indicates that the many ways of argumentation contributes to learning. Socratic inquiry, case based learning, studio science are all fertile ground to develop student voice and a logical approaches to argumentation.

4. Safe, low-risk environments allow students to externalize their own developing knowledge, supporting them in a meta-cognitive process of reflection and refinement. Finding a way to value the action of attempting something very difficult whether or not one succeed is a risk taking activity with pay off in innovation.

5. Leadership from central governments, academies of science, businesses and the faculty themselves must work in unison to push forward together. Recognition of the need of each to inspire a new generation of innovators for the better society whether it be a local government, country or global level.

6. Innovation in teams requires members to have both domain specific knowledge (discipline based content) and general knowledge and competencies. The higher education system and the elementary school systems are critical to maintaining high level, high expectation in learning and knowledge acquisition.

7. Investments in human resources, knowledge creation, education and our innovation spurring environments rest at the heart of our ability to address the challenges that confront us. Our current and future problems whether it be related to global warming, pollution, biodiversity or natural catastrophes are going to need the collective intellect and inspiration of a global community.

CHAPTER II

Strengthening Research in Higher Education

The Impact of Research on Higher Education in Germany

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General introduction

Generally speaking, there are different approaches on how to organise the systems of higher education and research and, most importantly, how to inter-link these two fields. In most Eastern European countries and the former Soviet Union, universities were mainly responsible for education with only little research activities, whereas the main bulk of research was conducted in Institutes of the National Academies or branch institutes. Recently, in some countries reform processes have been launched in order to strengthen the research capacities of universities and to broaden the scientific basis of the research system. In Germany, since the days of Wilhelm von Humboldt, the universities have been characterised by the unity of teaching and research. Universities are one of the main pillars of the German research system, next to eminent research organisations such as the Max-Planck-Society, the Helmholtz Association and the Fraunhofer Society. There is competition in the research field in order to get more scientific results, but not for State funds, as excellent institutes and institutions are sure to get their share.

Today, the concept of unity between teaching and research is not undisputed. In view of the growing number of students and in view of the time-consuming teaching tasks, university professors have been complaining lately that they have less and less time to dedicate to their research. However, excellent researchers know very well that the dialogue with their students can enrich their own research. Students must not been seen an obstacle to do research. Students are the life force of a university. At the same time, we cannot neglect the challenges the universities are facing when more and more students are entering an academic career. Politics in dialogue with the science community have to find the right answers in view to support research as well as teaching at universities. The unity of teaching and research is not an old-fashioned ideal coming to us from another century. It is highly appropriate to be translated into the 21st century.

Germany has a long tradition of its universities being active in research but is facing today the challenges of a globalised world economy. Like all industrialised countries, Germany has a growing need of a highly-qualified workforce in order to be internationally competitive and the universities play a fundamental role in this respect. As far as the research impact on higher education is concerned, the case of Germany is certainly ‘exemplary’. German universities are facing great challenges to maintain and extend their research capacities.

Before presenting some initiatives in details, in order to foster research within universities, we certainly have to consider two main reforms related to the general academic framework:

1) The Bologna Process

The Bologna process has an enormous impact on universities. This process is probably the most far-reaching university reform in recent times. Students and researchers are more mobile, more flexible and more international than ever before. Knowledge knows no national frontiers. Internationalization is a 'pacemaker' for reform and for the development and modernization of the higher education system. The institutions of higher education must assert themselves in the international competition for the best brains. In recent years, German universities were subject to a wide range of reforms to meet the requirements of the Bologna process.

With regard to the topic of this article the reform of the Doctoral training has to be highlighted. In September 2003, the European Education Ministers named doctoral training the so-called third cycle of the Bologna Process – in addition to Bachelor's and Master's courses. The aim behind this decision is to interlink the European Higher Education Area and the European Research Area. Doctorates play an important role here as the connecting link between the two areas.

2) The Higher Education Pact

The efficiency of research and highly qualified employees are key factors for a country's social and economic development. The demand on the labour market for higher education graduates is growing and will continue to grow in the future. At the same time, the number of A-Level holders applying for a study place will increase over the coming years. Institutions of higher education are an important element in the German research environment and thus also of Germany's economic performance. Young scientists acquire their qualifications at institutions of higher education. Participation of young scientists in research is the reason for the special position of institutions of higher education in the research system. The institutions of higher education are currently not only facing a growing number of persons interested in studies. They are also undergoing a comprehensive modernization of higher education by introducing Bachelor's and Master's degrees. In addition, they must prepare for increasing diversification on the basis of criteria of excellence and continually rising demands of autonomy and competition. The Federal and the States' Governments want to jointly meet these challenges in higher education and have signed a funding scheme for this purpose. Until 2010, the Federal States will receive their share of 565 Mio. €. Additionally, research projects at institutions of higher education financed through the German Research Foundation (DFG) will be financed with their overhead costs which was not the case before.

Within this academic framework, Germany has launched some political initiatives to better focus higher education and research in the country:

a. Initiative for Excellence

In 2005 the German Federal and the States' Governments agreed on an initiative to promote top-level research in Germany. The Excellence Initiative aims at strengthening science and research in Germany in the long term, improving its international competitiveness and raising the profile of the top performers in academia and research. International rankings prove that Germany has internationally competitive research institutions but that universities are not partaking in this success as they should. Therefore, the Excellence Initiative was launched in order to strengthen research at universities.

The Excellence initiative does not only aim at funding excellent, internationally visible research. The main goal of this initiative is to redevelop the universities into strong focal points of the German sciences system. This is supposed to be developed in cooperation and not in competition with the strong extra faculty research taking place in Max-Planck Institutes or Helmholtz centres.

This initiative released a strong dynamic among the universities as they were challenged to develop their research potential strategically and in a future-oriented manner.

The total budget of the initiative will be €1.9 billion for the period 2006 through 2011, which will be split between three lines of funding:

Graduate schools to promote young researchers
In this funding line Research Schools for young scientists will be established which provide structured PhD programmes within an excellent research environment and a broad area of science. About 40 research schools will each receive one million Euro/year on average. A total of 40 million Euro/year is available for this area.

Clusters of Excellence to promote world-class research
In this funding line internationally visible and competitive research and training institutions, so-called Excellence Clusters will be established at universities. They are required to cooperate with non-university research institutions, universities of applied sciences and industry. 6.5 million Euro/year will be available on average for each of these about 30 clusters, i.e. a total amount of 195 million Euro/year.

Institutional strategies to promote top-level university research
The promotion of 'Future concepts for top-class research at universities' is to heighten the profile of up to ten selected universities. A precondition for funding is that an institution of higher education should have at least one excellence cluster, one research school and a convincing overall strategy for becoming an internationally recognized so-called 'beacon of science'. A total of 210 million Euro/year has been earmarked for this area. The size of each funding project is to be 21 million Euro on average.

b. Research at Universities of Applied Sciences
There are almost 160 State-funded and State-recognized universities of applied science in Germany, which provide a broad range of subjects in engineering sciences, social sciences and economics. Furthermore, there is a growing number of interdisciplinary study courses, such as industrial engineering or biotechnology.

The Federal Ministry for Education and Research has set up a new funding programme supporting Networks between Universities of Applied Sciences and Enterprises. This programme aims at fostering an intensive knowledge and technology transfer into enterprises and improved training and qualification for students at the universities and for R&D personnel in the companies. Characteristics of this funding line are a demand-oriented funding, as well as application and transfer-oriented research projects. Another funding line in this area is the

Qualification Initiative for Young Engineering Scientists. Here, research groups of young scientists at universities for applied sciences will be initiated through innovative research projects and the potential in selected research fields will be strengthened.

The Federal Ministry for Education and Research also strongly encourages the participation of universities of applied sciences in the ministerial thematic programmes (e.g. optics, biotechnology, ICT etc.). In this funding line universities of applied sciences which were successful in a thematic programme receive supplementary funding for an independent research project in this area in order to maximise the added value resulting from their participation in the thematic programme.

Best practice examples of cooperation between research institutes and universities

Karlsruhe Institute of Technology (KIT): The Karlsruhe Institute of Technology (KIT) represents the merger of the Karlsruhe University with the Forschungszentrum Karlsruhe. They were among the winners of the first round of the Excellence Initiative. Both partners are joining their forces in KIT in order to achieve an unprecedented quality of cooperation. With the decision of the Federal Republic of Germany and the Federal State of Baden-Württemberg to merge both institutions in a public corporation from 2009, the legal and political pre-requisites have been created for the trend-setting KIT model. With around 8000 employees and an annual budget of about 700 million Euros, KIT will become an institution of top research and excellent academic education as well as a prominent location of academic life, life-long learning, comprehensive advanced training, unrestricted exchange of know-how, and sustainable innovation culture. Both partners offer education and training in the form of:

- Studies
- Vocational Training
- Karlsruhe Graduate School of Optics and Photonics
- Research Training Groups
- Post-graduate Studies
- PHD Thesis
- Diploma/Master Thesis
- Student Projects
- Internships
- International Programmes
- Invitations of International Scientists
- Training

KIT research is primarily based on the capacities and on the knowledge of its scientists, who are members of more than 140 Institutes within KIT. They are supported by an excellent and worldwide unique scientific infrastructure. In KIT these scientists work in fields of competence depending on their expert ‘know-how’. Related fields of competence are bundled in areas of competence.

JARA: In August 2007, the Rhenish Westphalian Technical University of Aachen and the neighbouring Research Centre Jülich signed a contract which established the Jülich-Aachen Research Alliance (JARA). The alliance links fields of excellent research in promising areas at the two institutions with the aim to develop a common research route. Research objectives will be defined and created in a joint process, the infrastructure and equipment available to research and education will be shared, educational activities will be jointly developed, and personnel and investment decisions will be taken in a corporate process. The overall goal of JARA is to implement the Aachen/Jülich region as one of the top research locations in Europe and one that will be recognised worldwide for research and scientific education. It should be mentioned that this region is already part of an 'EU-regio' interlinked with neighbouring regions in the Nederlands and Belgium. JARA will kick off in four promising fields of research:

- JARA-BRAIN (Translational Brain Medicine),
- JARA-FIT (Fundamentals of Future Information Technology)
- JARA-Energy (Energy Research) and
- JARA-SIM (Simulation Sciences)

As a final cooperation scheme let me mention **Max Planck Fellows Programme:** With the pilot programme 'Max Planck Fellows', the cooperation between universities and Max-Planck institutes will be intensified. Through this programme, university professors can become a temporary Max Planck Fellow. They are able to head a research group at a Max Planck institute for the time of five years and funded by the Max Planck society.

Central European Initiative: Incentives Supporting Science and Technology

Ambassador **Pietro Ercole AGO**
Secretary General, CEI-ES

The CEI, the oldest and the largest of regional bodies in Europe, is composed of 18 Member States of Central, Eastern and South-eastern Europe: Albania, Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Hungary, Italy, Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia and Ukraine.

The strategic goal of the CEI can be expressed in two words: cohesion and solidarity. *Cohesion* means that we use our means in order to bring our Member States closer together in building networks, contacts among institutions and individuals, reducing the dividing lines which exist and trying to mitigate the impact of new dividing lines which might emerge, e.g. as a consequence of EU enlargement. *Solidarity* means to use our means to assist our Member States in their institutional and economic development. Naturally, there are major differences among our countries and, therefore, this help frequently takes the form of know-how transfer from West to East.

In order to facilitate the implementation of programmes and projects, either organized or sponsored by the CEI, and to foster a concrete and bottom-up cooperation between and among its Member States, the CEI has various instruments at its disposal.

As far as education is concerned, let me draw you attention to the **CEI University Network**. The basic principle of this Network is the cooperation of universities in our Member States in the form of Joint Programmes, which presuppose the cooperation of at least two universities in the framework of Masters' degree courses, summer courses or Ph.D. courses. We support financially the mobility of participants, paying teaching grants and scholarships for the academic staff and for students coming from abroad.

The Network focuses on the following priority areas:
- economics (including sustainable development);
- infrastructure and transport;
- urban planning and regional development;
- public administration and governance;
- communication and information technology.

A kind of a counterpart, yet conceived in quite a different manner, is the **CEI Science and Technology Network**, which is built on the six Trieste-based Research Centres acting as leading Institutions of the Network, namely:
- International Centre for Genetic Engineering and Biotechnology (ICGEB);
- International Centre for Science and High Technology of UNIDO (ICS-UNIDO);
- 'Abdus Salam' International Centre for Theoretical Physics;
- International School for Advanced Studies (SISSA);
- Synchrotron ELETTRA;
- Consortium AREA.

With each of these leading Institutions the CEI has concluded a Protocol defining the area and modalities of cooperation. It is complemented by an annual Work Programme which specifies the activities to be conducted under CEI sponsorship and the financial contribution to be made by the CEI from its funds. Each of these Institutions disposes of a network of partner organizations in CEI member States which constitute the so-called 'Secondary Network' and with whom the programmes supported by the CEI should be developed in joint efforts.

In 2005, the **CEI Research Fellowship Programme** was established with the aim to enable mobility across the CEI region by giving awarded scientists the possibility of carrying out research in one of the Network's institution. Over the years, the request for funding fellowships has been constantly increasing, thus showing the effectiveness of the Programme itself. With the aim of seeking additional funds for this Programme, the CEI has submitted to the EU 7th Framework Programme the project proposal called 'CERES - CEI Research Fellowship Programme', which was positively evaluated and recently approved.

With the programme **'From Research to Enterprise'** the CEI offers incentives to scientists willing to commercialize the results of their research, with the ultimate purpose of building a bridge between science and entrepreneurship. In particular, the CEI provides financial support to the selected participants in the form of seed-money to be used for financing a feasibility study or developing a business plan. The CEI has so far completed two editions of this programme (in 2004 and 2006) and we are willing to renew this programme for next year.

Considering that the primary scope of the CEI is to assist those countries remaining outside of the EU to consolidate their structures and capabilities on their path towards European integration, the following two priority areas of CEI cooperation deserve particular mentioning. They respond to the needs of CEI Member States and notably contribute to strengthen the role of the CEI in project-related cooperation – which would hopefully enable our organisation to achieve a better recognition and visibility in Brussels.

The **Know-how Exchange Programme (KEP)** is tailor made to support the transfer of know-how acquired during the EU accession process by the new EU Member States to those remaining for the time being outside of the EU, but aspiring at membership and, therefore, in need to adapt and harmonize their standards and legislation. Here, the capacity building – conceived both as strengthening of proper policy and legal frameworks as well as human resources development – plays a central role in the list of KEP priority areas of intervention.

We believe that such programme might also help maintain and even raise the interest of the seven recent EU countries to remain active in the CEI and we count on the interest of all these countries to use - as well - the CEI for helping their neighbours not to remain outside the EU borders too long.

The **CEI Partnership with EU Projects** has become more and more important both in terms of the areas of cooperation and in terms of EU funding allocated to the CEI since 2004. The comparative advantage of the CEI has been an important asset in the participation in EU funded projects, in particular after the EU enlargement when an increased number of CEI countries

has become eligible for EU funding. The attention is also focused on the involvement of Central and Eastern European countries in EU projects and programmes, identifying appropriate partner institutions in non-EU members for their inclusion in European projects.
In this context, I would like to recall the CEI involvement as full-fledged partner in some EU-funded projects, tackling issues such as educational methodologies in sustainable development (*RAVE Space Project*); transition of SEE countries to information societies (*Great-IST project*); development of renewable energies, in the spirit of economic competitiveness and adoption of modern and proved technologies (*BIOM-ADRIA project*).

In conclusion, I see in this context room for the CEI to put its well-established structures and instruments at your disposal to contribute to further promote regional cooperation in education and science, especially by means of establishing and facilitating networking activities; disseminating best practices; seeking for funding opportunities.

Priority should be definitely given to the transformation of transition societies into knowledge-based societies, considering higher education and national research as key elements of this process.

The Contribution of the Albanian Academy of Sciences to Strengthening Research in Higher Education

Teki BIÇOKU
President, Academy of Sciences of Albania (ASA)

Salvatore BUSHATI
Scientific Secretary, Natural and Technical Sciences Section, Academy of Sciences of Albania

Following a Government decision, the ASA research institutions and centres have been transferred to the higher education institutions in order to upgrade the quality of human resources and infrastructure in the universities in Albania. As a consequence, ASA should be developed into a competitive and capable Academy and should contribute to the overall progress and to the educational and scientific development process.

In the framework of ASA reform, 14 scientific research institutes and centers have been incorporated in the universities creating new inter-university centers, institutes, faculties and departments. In this way a valuable contribution to the strengthening of capacities of human resources and research scientific infrastructure higher education was made.

As a result, all institutes of social and Albanological sciences merged into the Inter-university Center of Social and Albanological Studies, which stands at an inter-university level.

One new faculty and two research institutes have been affiliated to the Polytechnic University of Tirana ; the Institute of Informatics and Applied Mathematics of ASA became the Faculty of Technologies of Information, within which the Center for Research and Development of Information Technologies was created.

The Institute of Geosciences was created by joining together the Institute of Seismology of ASA, the Institute of Geology and some departments from Albanian Geological Survey. At the same time the Institute of Hydro-Meteorology and the Center of Hydraulic Studies of ASA have created the new Institute of Energy, Water and Environment.

In the framework of this reform, the University of Tirana created as well one research center and a new department.

The ASA Institute of Biological Research was transformed into a Department of Food Technology, while the Institute of Nuclear Physics became a Center of Nuclear and Applied Physics.

The new system of scientific research in Albania also states that ASA is not coordinating anymore scientific research institutions and centers; however its role is not weakened as it becomes even more important due to its new responsibility, i.e. to fulfill the implementation at national level of the entire strategy of education and scientific research, which covers the entire higher education system.

The research system in Albania and ASA are presented bellow. According to a new law regulating its activities and approved by the Parliament, ASA is a public institution whose annual budget is covered by the Government.

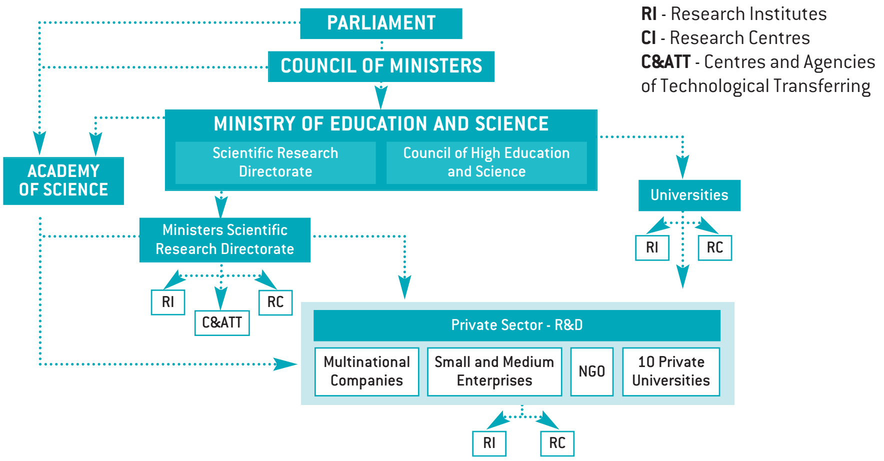

Fig.1. Scientific system in Albania

The organization of the current ASA administration is to be revised with the aim of creating more effective structures. ASA is currently cooperating with the Ministry of Education and Science and others ministries of the country, with universities, and also with other public and private institutions.

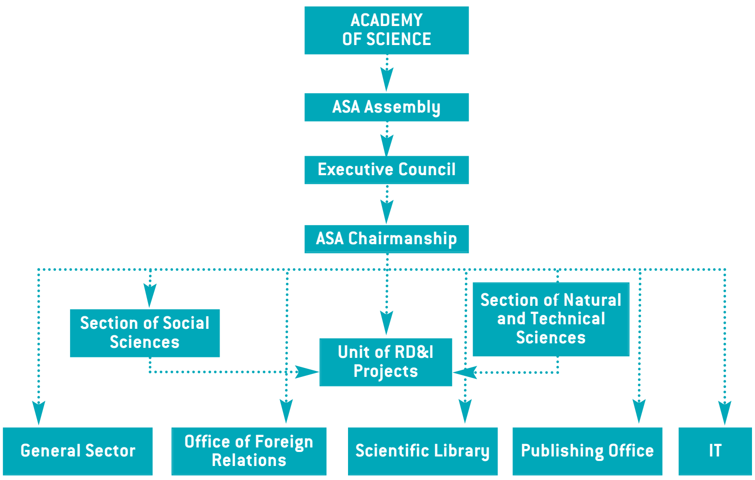

Fig. 2 The organizational Chart of the Academy of Sciences of Albania

The Academy of Sciences, based on the priority fields of development of the country, will create permanent or provisional commissions composed by the best specialists, in order to carry out special studies of national importance, which will be put at the disposal of the decision-makers. Such commissions might focus on issues like: education and science, water, energy, civil emergencies, agriculture and food, biodiversity, life quality, environment, language, history, culture and cultural heritage, sociology, economy, financial and demographic problems etc. These commissions will be leaded by the most outstanding academics and specialists from the country and those who work outside.

The main priority is to contribute to the higher education and to strength its research capacities:

The ASA academic staff makes a valuable contribution by:

- *Teaching and performing scientific research* in higher education: e.g. holding academic positions in different disciplines in universities, coordinating various sectors, departments and faculties, and participating as members of scientific councils, 'qualification' commissions and *ad-hoc* working groups in universities and contributing to increasing the capacities of teaching in various institutions of higher education (e.g. drafting in educational curricula);
- *Acting as legal advisors:* e.g. drafting various proposals on legal acts regarding higher education and science and participating in the process of their implementation**;**
- *Providing know-how:* e.g., participation in the activities of various highly relevant national higher education and scienctific *institutions*, such as in the Commission of Higher Education and Science (CHES), Commission of Scientific Qualification (CSQ), etc.;
- *Authoring publications:* they draft/edit/publish textbooks, monographs, books (about 50 titles per year), magazines, periodicals and scientific bulletins (more than 11 titles per year). The main publications are also published electronically (CEOL). Also, they are involved in bibliographical activities (both within the country and abroad);
- Managing projects: they manage and develop national R&D projects;
- *Coordinating institutional international relations:* coordination of projects at different levels with the participation of the researchers from universities:
  - international (EU framework Programmes 6, 7 etc.; NATO Programmes, INTERREG-II, III; Transboundary Programmes; Bilateral programmes with Greece, Italy, Macedonia, Slovenia, etc.);
  - national (funded by the State budget);
- *Cooperating with private sector: conceiving and coordinating cooperation between scientific institutions with private business* for:
  - transferring and applying innovative technologies in production,
  - establishing nucleus of research-development in institutions private business,
  - increasing capacities of agencies of technology transfer in different fields of production,
  - stimulating innovative acts and their application in producing practice, etc.
- *Developing capacity building activities:* increasing the capacities of scientific research institutions, drafting proposals on new scientific institutions (e.g. the International Center of Marine Sciences, funded under INTERREG-III; Permanent Network of Global Position System, funded by NATO Science for Peace Programme; etc.);
- *Providing analysis:* monitoring and studying the potential of scientific research in various fields, evidencing phenomena, problems and formulating recommendations for improving the actual situation (Research Potential – FP6);

- *Authoring studies related to human resources in science:* e.g. draft studies on various topics related to the improvement of human resources capacities, such as:
  - *brain drain:* evaluate and analyze the situation (involving decision makers and the scientific community);
  - *brain gain:* contribute to the international study on the phenomena, aimed at finding ways to enhance it and proposing practical solutions; with regard to this issue, ASA was one of the first collaborators of the EU and of the NATO Public Diplomacy Division (e.g. the Reintegration Grant-NATO Programme, that was successfully put into practice);
  - *brain circulation:* draft the Albanian normative framework on the mobility of researchers (including that of foreigners in Albanian academic institutions), e.g. the international project 'Web-MOB-FP6', coordinated by ASA, involved various partners from CERTH and other institutions in Albania and Greece.
- *Coordinating joint programmes:* numerous researchers participate in joint programmes / projects of ASA, in cooperation with international partners such as: national Academies of Science, IAP, TWAS, the Network of Academies of Europe, etc.;
- *Performing and managing research:* e.g. ASA develops various research programmes and projects while involving all universities in priority programmes of IAP, such as on the framework of:
  - Science Education,
  - Access to Scientific Information,
  - Capacity Building for Young Academies,
  - Genetic Modified Organisms (GMOs),
  - Bio-security,
  - Health Education of Women,
  - Water.

The Academy of Sciences, as an elite scientific institution of national value, include outstanding personalities in the field of science, as well as outstanding personalities in the field of literary and artistic creativity.

In the future, the Academy will aim to be not only the 'house' of academics, but also an open institution for close cooperation with scholars of different generations, scientific communities and civil society.

The Scientific-Educational Cluster of the Academy of Sciences in the Republic of Moldova: 'Univer Science'

Professor **Gheorghe DUCA**
President, Academy of Sciences,
Republic of Moldova

Science and education in Moldova have never been considered two separate and unlinked spheres. During the 'soviet' period the Moldovan universities were characterized by a strong education and partial research, while academic institutions performed strong research and partial education.

Regretfully, after the collapse of USSR, the lack of sufficient funds affected negatively the existent education and scientific potential and led to the deterioration of the technical-scientific basis. Moldovan science is faced with out of date equipment, low salaries, lack of renovation in laboratories, lack of young people in science and 'brain drain'.

All these created the ground for launching a new R&D reform. In 2004, with the adoption of the Code on Science and Innovation, the role of the Academy of Sciences has changed radically as it has been entrusted 'governmental responsibilities' in the fields of science and innovation. According to the above mentioned Code, which serves as a Constitution for the scientific community, the Academy of Sciences of Moldova (ASM) became the manager of the scientific and innovation system of the country.

According to the Code, the Academy of Sciences concluded a Partnership Agreement with the Government which stipulates, among others, an important thing: an increased budget for financing science and innovation activities. The increase of the budget allowed to supply laboratories with new and modern equipment, to use up-to-date information technologies, to increase wages, to establish a modern scientific library.

The knowledge-based society requires high qualified and skilled specialists, capable to use efficiently the knowledge and new technologies. From this perspective the competent education of the new generation is a very important social problem for many States, as well as for Moldova. Pupils and students performances tend to some average standards within the centralized education system, so that it is difficult to create special conditions for improving the capacities of gifted and talented young people in general school. Apart from this, general educational institutions are equipped unsatisfactory with laboratory facilities for researches, especially in rural area.

It is important to mention that today the education of gifted young people represents one of the top world priorities. This has already been confirmed in the National programmes that have recently been approved, and by the newly created centres of excellence etc. Below is a series of examples:

- Specialized schools affiliated to universities and academic centres (Russian Federation, Estonia);

- Centres of scientific education (Serbia, Israel, Italy);
- Centres of excellence (Germany, Romania);
- Academies for gifted children (USA, Canada, Australia).

Who can be considered 'gifted' and what kind of conditions he/she needs? There is no clear definition. It depends on each case, because every child is 'gifted 'in a different way and has certain abilities. In any case, there are some common characteristics that can be mentioned:
- high intellectual abilities (their IQ is higher then 130 in comparison with average IQ of 80-100);
- critical or creative mind (the information obtained at lessons and from manuals is insufficient, so that they read a lot and all the time ask *'why?'*);
- special interest for concrete area (often they have good academic progress in interested disciplines in contrast to other marks, so that general average mark is not very high);
- extraordinary memory (they are quick in new material assimilation);
- lack of patience, especially in routine and mechanic activities;
- unusual and unexpected answers.

According to specialists gifted children need:
- special conditions for study;
- individual education that will take in consideration the peculiarities of every pupil or student;
- practical activities and initiation in scientific researches;
- team work.

In these conditions the Academy of Sciences of Moldova decided to create a scientific educational Cluster.

A scientific educational cluster represents an association of specialized and competitive structures in research and education that can assure excellence in science, creating premises for integration of research with education, as well as innovation premises between research and education institutions, State and private sector, commercial associations and other structures. The main peculiarity of the Cluster consists in its capacity to share infrastructure, markets and services. Following this, the specific objectives of the scientific education cluster are: professional education of researchers; high performance; competitiveness based on scientific criteria, insuring specialization on specific domains; growth of innovative capacity through program expansion; management experience; obtaining of management and marketing capacity in research-development.

The scientific educational Cluster of the Academy of Sciences of Moldova **'UnivER SCIENCE'** consists of the Lyceum of ASM for gifted children, university of ASM, research institutions, scientific Technological Park, an Innovative Incubator and additional services of the Academy.

The Lyceum of ASM was founded under the decision of Moldovan Government Nr. 1342 of 23.11.2006 with the aim of providing a modern and quality education to gifted children from Moldova. Each child, all the more gifted one, is an individual with particular capabilities and needs. That is why the primary objective of the Lyceum is to teach and develop basic academic skills.

The Government and the Academy of Sciences offer to the pupils of Lyceum excellent and free of charge conditions. The process of training includes following methods: hands-on experiments, individual tutoring, e-learning, competitions, advanced and enrichment lectures for the students by prominent scientist, scientific tours and excursions. So, gifted children should be able to benefit from special educational conditions that would allow them to develop fully their abilities, for their own benefit and for the benefit of society and country as a whole.

The idea of establishing the University of ASM was determined on the one hand, by the fact that the Academy covers a wide array of research directions and engages the most noteworthy scientists of Moldova. On the other hand, the Academy's infrastructure including facilities, space, and equipment is used too seldom in the process of education. And finally, such University is strongly necessary to the academic institutions, which must continue to improve and develop by training, engaging and promoting young researchers.

The University was established upon the Decree of the President of the Republic of Moldova regarding the foundation of the University of the Academy of Sciences of Moldova Nr.1093-IV on April 23, 2007, as a State institution of higher education that legally activates on the basis of its statute, and is funded from and within the limits of state budget allocation approved by the Academy of Sciences of Moldova for education.

As opposed to other institutions of higher education of Moldova, the process of training in the University of ASM is realized through integration of teaching with research, of science with technologies, of theory with innovation experience.

The Programmes of the University of ASM include: Communication Program, Teaching and Learning Program, Business Administration, Technology and Society.

The University of ASM prepares the wide-range of general, basic and specialized courses, providing students with the opportunity to choose either a basic or integrated specialty or even a narrower specialty.

Unlike other Moldovan Universities, teachers of the University of ASM are mostly scientists and researchers who deliver just one specialty course.

By creating scientific educational Cluster of the Academy of Sciences of Moldova 'UnivER SCIENCE' the system of the Academy of Sciences of Moldova consisting of 3 components: Science, innovation and education, was completed.

Science for Education, Education for Science

Momir DJUROVIĆ
President, Academy of Sciences and Arts, Montenegro

Science, education and society

Science and technology are today increasingly important in all aspects of our life, in our private lives as well as in working situations. Science and technology are widely involved in decisions at personal as well as at wider social and political scale levels. In society we are asked permanently to take care of socio-scientific issues. Life in a democratic society, like the process of taking political decisions, need to appreciate universal and human values and ideas as well as the use of scientific knowledge. In any democratic society, the public perception of and knowledge about different issues related to S&T have become very important.

By contrast to such a situation, there is a lack of students' interest in science and technology. Today, still, students believe that science is a collection of facts to be memorized, that all the information in science textbook is true, that the sum total of scientific knowledge is known and that science is a quantitative, value-free, empirical discipline. The subjects that are supposed to describe real and concrete world are considered to be abstract and irrelevant. Moreover, they often fail to understand that science preexists on the basis of many trials and fits, that ideas based on evidence are still to be questioned, that scientific work and ideas are enhanced through a process of sharing, negotiation, and consensus building, and that science is continual inquiry as well in fundamental topics already elaborated. It is problematic, too, that while science and technology has profound consequences for our present and future life, many young people seem to develop holistic or ambivalent attitudes towards S&T. At the same time, the general public is vaguely informed on the progress and the risks science can generate.

Rapid societal and other changes we experience necessitate to construct a new image of the process of schooling in general, and the process of teaching and learning science in particular. We all, still, do not appreciate that education is the sum of values, skills and opportunities. Science education, formal and informal, can be developed in many ways. It has been shown that globalization implies a pressure to universalize and harmonize the process and contents of education. This force countries to try to set strong regional or local directives concerning education with a pressure to universalize and harmonize, and to strive towards common contents, curricula, testing methods, indicators and benchmarkers.

Planners and policy makers usually use approaches from top down identifying national goals which can be transferred into policy for different sub-sectors. Most developed countries envisage national plans in which they set commitments to invest in education, science and technology with the belief to enhance economic development and health of their people.

Another way, which is becoming more and more common today, is to argue that specific policy of science and technology is needed in association with particular economic development strategies. This leads to decisions about the fields of science and technology, professional education and training that should be promoted, as well as about the mechanism to be put in place in order to educate the general public on science progress. Raising the pubic awareness on the threats and risks which science - when is misused or wrongly used, deliberately or by error - can produce has become very important, but at present it is merely negligible.

In the past two decades, a consensus has emerged that science should be a compulsory school subject. However, whilst there is agreement that science education is important for all students, there has been little discussion on its nature and structure. The quality of school education in science and technology has never before been of such critical importance to governments. There are many imperatives for its critical importance. Some relate to the traditional role of science in schooling, on the preparation of those students who will continue their careers in science and technology. A sufficient supply of these professionals is vital for the economy of any country and for the health of its citizens. It is recognized everywhere that people educated in S&T are key players in ensuring that industrial and economic development occurs in a socially and environmentally sustainable way. On the contrary, in many countries the supply of these people is seriously short and urgently needs to be addressed. The next imperative is that of sustainable technological development. Many other possible societal applications of science require the support of scientifically and technologically educated and informed citizens. This goal is far from being generally achieved at present. Furthermore, some imperatives derive from changes due the application of digital technologies that is the most rapid, the most widespread, and probably the most pervasive influence that science has ever had on human society. Science and technology education needs to be a key component in developing these competencies elsewhere.

Today and in near future many countries experience significant problems with engaging students with the advanced study of STEM (science, technology, engineering, mathematics). However, this pattern is not universal across the world and appears to be strongly correlated to the level of economical development in any given country. It is more experienced in western European countries. Such, at the beginning of this century the number of students studding STEM has fallen in Poland, Portugal and France, Germany and Netherlands. Furthermore the number of students engaging in Ph.D. in these disciplines has dropped generally in all European countries. This phenomenon would be even more obvious if foreign students are not taken in consideration. The case with post-doctoral studies is even worst. The consequence of this situation is that the supply of scientists to sustain knowledge economies, which are heavily dependent on science and technology, has become a significant problem.

Attempting to adjust the supply of professionals by improving science education is a long-term process, and some effects can be achieved within a decade. In a market economy supply and demand are best kept in balance by adjusting the payments made to suppliers - in this case to individual scientists and technologists, especially young. There is still no evidence that a serious move to solve those problems has been done. The problem with young scientists is even more alarming as far as financial support is concerned. The best example is the status of doctoral and especially post-doctoral students. One has to remember that in former socialist countries this problem was basically solved. The practice of many liberal European nations is that education should serve the purpose of offering young people the best that is worth knowing. In many western European countries it is said that education should develop the full potential of individuals. Except for improving the financial status of graduate and postdoctoral students they should also be encouraged to improve their teaching and managerial skills. Universities could provide more teaching experiences for graduates and postdoctoral students by making arrangements that would allow them to teach, as well as to actively participate in the management of research. In contrast with the theoretical principles, the explanation used in praxis is that the primary goal of including science in school curricula is because it is an important part of European cultural heritage which provides the most acceptable explanations on the material world.

There is still a lack of clear vision across Europe with regard to the purpose and goal of formal science education. On informal education even more! That might be best shown in the process of applying the Bologna process. On the one hand, school science is essential to produce the next generation of scientists, engineers and doctors and, on the another hand, it is a dominant part of contemporary culture, a way of knowing about the material world of which all should have some rudimental understanding. Evidence has shown that the first of these goals largely determines the nature of school science at the expense of curriculum that might meet the needs of the majority.

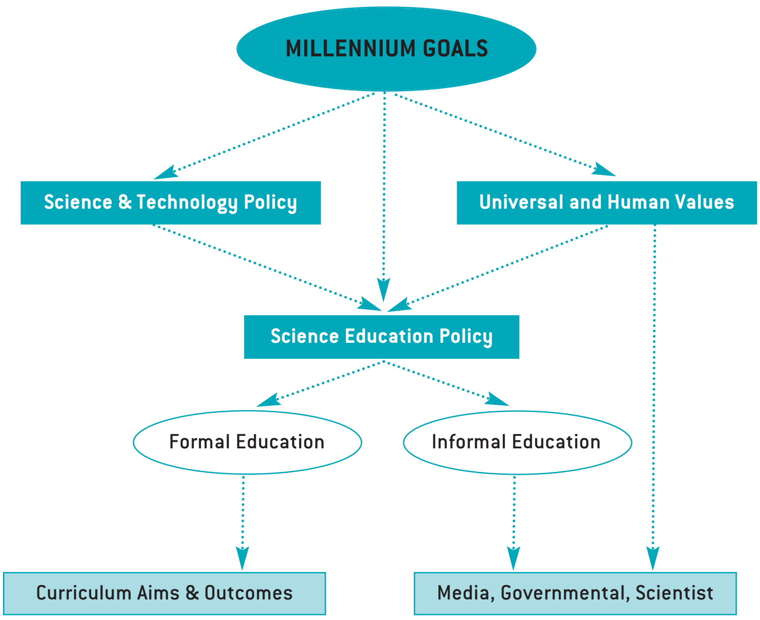

Fig.1. Education process

Obviously the primary goal of science education cannot be simply producing the next generation of scientists. Society has to rather focus on training young people and the general public towards understanding major themes that science has to offer and contributing through their abilities to use science in their future lives, as well as pointing out at its potential risks and threats. Achieving this goal requires a long-term investment in curricula; this further implies the improvement of teachers's skills, knowledge and pedagogy methods, as well as the creation of systems that adequately reflect the goals and outcomes for science education in general. As far as general society is concerned, except some media attempts to promote science, there is any serious attempt in this direction. Never in history it has been so important to educate and raise awareness on the possibilities new knowledge is offering in both directions: for prosperous life as well as for 'prosperous' failures.

Certainly, the main solution in solving the problems related to science education is to keep asking the following question in any country: 'Does science have any influence on contemporary society in the country?'.

Science, education and sustainability

The issue of 'sustainable development' needs a be tackled with special attention. The problem has been widely recognized and in particular supported by *the 'Ubuntu Declaration'* which calls for strenightening science and technology education worldwide as a key factor in order to reach sustainable development. The integrated solutions for sustainable development depend on the continued and effective application of science and technology, in which education is critical in galvanizing the approach to the challenges of sustainable development. The document says that *'Science is all science – natural, social and humanities'*. This has to be recognized since without social sciences and humanities it is often not possible to apply the knowledge produced by natural sciences and technology. Furthermore, it has to be acknowledged that the ultimate goal of education in all its forms is to impart knowledge, skills and values to empower people to bring about changes understanding to all of their aspects. In this manner it should be recognized that the scientific and technological community has called for a new social contract between science and technology society for sustainable development.

In particular it is required to review the programmes and curricula of schools and universities in order to better address the challenges and opportunities of sustainable development, with a focus on:
- Creating learning modules which bring skills, knowledge, reflections, ethics and values together in a balanced way;
- Problem-based education at primary and secondary levels in order to develop integrated and non-instrumental approaches to problem solving at an early stage in the education cycle;
- Problem-based scientific research in tertiary education, both as a pedagogical approach and as a research function.

There is a priority need to develop mechanisms to continuously inform teachers and update programmes on major progress in scientific and technological knowledge relevant for sustainable development. This will require promoting knowledge transfer in innovative ways in order to speed up the process of bridging the gaps and inequalities in knowledge sharing. This is the joint responsibility of teachers, schools, research and education institutions and governments.

The Ubuntu Declaration pays a special attention to the need of society to become more familiar with various issues related to science and technology education, such as climate change. For that it is needed to:

1. broaden the understanding of human induced global warming, possible long- and short-term consequences, and potential solutions;
2. apply the latest scientific and technological discoveries to provide learning opportunities to people; and
3. emphasize actionable information to help people understand, and promote implementation of new technologies, programmes, and incentives related to energy conservation, renewable energy, and greenhouse gas reduction.

The Ubuntu Declaration did not acknowledge that there is no time to be wasted if we want to achieve sustainable development. In fact we have to reach 'sustainable present' in order to ensure 'sustainable future'.

The role of Academies

As far as the role of national academies in science education is concerned (formal and informal) it should be underlined that they play a key role and in some fields there is no other institution capable to replace their activities. In particular they should concentrate on:

- developing codes for science and relevant education;
- enhancing the participation of individual members in public science educational programs;
- communicating more with university on issues related to curricula;
- accepting young scientists as members;
- initiating discussions on new procedures for investigating allegations of scientific misconduct (by means of an independent national body, State or independent institution);
- creating new incentive programmes to encourage young students to become scientists, engineers, and tech-savvy entrepreneurs;
- contributing to performing 'better research', i.e. improving the way science is taught in schools by supporting the teaching of science using the 'inquiry' model rather than the 'memorizing facts' model ;
- improving science tests; in this era of increased testing and accountability, it is crucial that we develop and apply the right kind of science tests; young scientists should be tested for science understanding rather than for mere knowledge of scientific facts;
- stimulating 'Research leading to innovation' by providing tools to utilize research for new products and rewarding individuals for being innovative;
- supporting radical ideas that may disrupt the 'status quo': seek venture capital investments in new innovations;
- encouraging researchers in science and technology to link up with human and social sciences in general, and with multidisciplinary research activities, in particular.

Conclusions

In the light of the goals for science education, it is imperative that we begin the process of researching and re-examining the relationships among science curricula, schools, colleges/universities, and society. Today's science is more accurately portrayed as a value-laden discipline in which there are many moral and ethical dimensions. New advances and new ideas must be investigated in relevant settings, and findings must be shared, discussed, refined and re-evaluated. Ultimately, a special focus should be put on the needs of individuals and student groups (in various cultural, historical, socioeconomic, racial and gender settings), as well as on activities to raise the awareness of public on science. Such a process is slow and involves not well-enough exploited ways.

While much knowledge has been accumulated from basic research, the process of ensuring that the needed innovations are integrated into the culture of schooling has just only begun. The role of science education and teaching is to increase our understandings of science and ensure that all students, preschool through college, acquire the scientific literacy requisite for lifelong learning.

Within the context of the new image of teaching science, students have to be educated to be active, critical thinkers in a rapidly changing scientific and technological society, 'to think locally and work globally', to try to solve problems globally. At the same time, scientists as well as governments should try all to educate the public at large on scientific progress, possible benefits from it, as well as possible hazards science can generate. Special attention has to be paid to 'unversal values' since it might be expected that they will start changing with new knowledge faster that in the past, as it is discussed by the Millennium Project.

Literature

- Alberts, B. (2004) Science Education: *No bigger Challenge for Science and Scientists Everywhere*, Promoting Science, Education and Society: The Academy-Government Challenge, The Israel Academy of Sciences and Humanities, Jerusalem.
- Djurovic, M. (2008) *National academies and competitiveness. Towards regional competitiveness in SEE*, BAS, Sofia 4-5 April.
- Djurovic, M. (2006) *Whose responsibility is greater?*, The meeting of SEE National Academies, Tirana, 2006.
- Drenth, P.J. (2005): *Scientific integrity and social responsibility: The role of Academies of Sciences*, ALLEA, Annual report.
- Glenn, J.C. and Gordon, T. J. (2007), *State of the Future*, Millennium Project.
- *Ubuntu Declaration on Education and Science and Technology for Sustainable Development*, World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002.

Strengthening Research in Higher Education: the Macedonian Approach

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Introduction

The Republic of Macedonia[12] is undergoing a process of transition and facing many challenges on the way to the integration into the European Union and NATO. Dedicated to achieve this goal, the country is undertaking a complex transformation of the overall social system which consists in reforming its institutional, economic, judicial, educational, etc. structures.

Ever since the beginning of the creation of the Republic of Macedonia as an autonomous and independent State after the fall of the Socialist Federative Republic of Yugoslavia, it has been widely acknowledged that the future of the country lies in well-trained and educated youth, eager to search for new experiences and knowledge. Therefore, investments in education connected with the research process are of utmost importance and a priority for the country.

Defining the right approach in the process of reaching the European *acquis* has been crucial in the country's efforts towards the integration into the European Union. Education and science are autonomous spheres and represent a significant part of the civil society. The reform process has took into consideration the European orientation of the country, and its establishment have been closely monitored lately through a serious 'check up'.

The adoption of the European *acquis* implied the outset of the Strategy for higher education and science as top priority, together with the adoption of an appropriate legal framework (*Law on higher education*) through partnership between the State and autonomous spheres of the civil society. Redefining the role of the State for the development of higher education and science is, *per se,* the confirmation of the commitment to reform, as well as the European orientation of our country.

For accomplishing the prerequisites for the adoption of a good legislation, several starting conditions are, therefore, important:

- higher education and science are the most propulsive areas of social development with multidimensional implications on the progress of the economy and other spheres of the social life, social promotion and democratization within the knowledge-based society;
- investment in education in general, and in higher education and research and development (R&D) in particular, is the most fruitful investment on short term, especially for a State such as ours that, on the one side, has no clear perspectives for investment in certain economic areas, and on the other side, has not developed yet an efficient concept for attracting foreign investments;

[12] *Within the United Nations, the country is referred to as "the former Yugoslav Republic of Macedonia".*

- the 'integration' of higher education and science, together with their development in the direction of the 'European flow' is not a process that can be accomplished with legislative actions taken over night that end up to be superficial organizational interventions (e.g., integrated university) or 'fashionable chase' of the new technologies in the higher education (the Bologna process) without understanding the essence of the new philosophy of the century of knowledge and research, that represents the European concept of higher education and scientific research development;
- the need of harmonization of the domestic legislation with the European standards for these areas does not mean transplanting some strict norms of the EU law in the national ones, because the European *acquis* in these areas is more like a 'circled' concept of strategic goals and instruments for their achievement formulated in the so-called 'soft *acquis*' (standards, directions etc.). Therefore, without previous comprehensive and deep discussion about these standards, as well as discussion for the determination and the objective possibilities for their progressive accomplishment, the proclaimed policy of the State on the development of higher education and science cannot be defined. Lacking that, any legislative solution can turn into waste of time and false believe that what is preformed means reform in these two vital areas of social development;
- finally, the policies in these areas and then the legislative regulation that refers to all the issues of the development of higher education and science (including the budget and the laws on the matter of financing, labour relations etc.), need to be defined through equal dialogue and partnership between, on the one side, the Government and, on the other side, the university and the scientific institutions (MASA, the scientific institutes) as autonomous representatives of these areas. The lethal paternalistic and one-side governmental policy practiced in the past left negative consequences not only for these areas but also for the overall social development. The process of reparation will take decades. Therefore, we ask for a new approach that will mainly strengthen on the one hand, the responsibility of universities and of similar institutions for their own future development and, on the other hand, the application of European standards in the development process of the above-mentioned universities.

The development of higher education and science is an essential prerequisite for the negotiations process for the membership of our country to the European Union. Regarding the views of the European Union about the present conditions in these areas - expressed in the analytical Reports of the European Commission, the Reports about the progress made in the past period, the Decision of the Council on the principles, priorities and conditions contained in the European partnership, the Stabilization and Association Agreement etc., - we could mention that these estimations and conclusions refer to the following: our country needs to obtain the necessary capacities in the areas of research, technological development and human resources for strengthening these capacities (the present conditions put the country on the bottom of the list indicating figures about investments made in these areas). Our country is characterized by a very small percentage of GDP spent for research and development (approximately 0,2%) and it is far from the respective figure in the European Union member States and far from the determination of the EU to reach 3% of the GDP investment in research until 2010. Therefore, it is recommended to increase the State funding for research and innovations and to participate actively in the European Research Area. Although progress has been made in the education area from a legislative point of view, our country should continue this process joining also the programmes like 'Youth in action' and 'Life-long learning' according to the other recommendations concerning actions to be taken.

Short review of the European vision on higher education and research

With reference to the subject of the European *acquis* in the area of higher education and science, it is important to mention the determination of the European Union for an 'Europe as unique area of knowledge and research'. The number of legal acts in the EU establishing the standards for higher education, research and development is very high and of different types. Not having ambitions to elaborate these documents, which, according to our belief, are well known, I would only like to remind some of them:

- The Lisbon Strategy (Conclusions of the European Council, Lisbon, 2000);
- The European Council Conclusions of the Summit in Barcelona, 2002;
- The 'Education and Training 2010' Programme;
- The 'Youth in action' programme (2007-1013);
- The Recommendation EC 561/98 and the Recommendation of the European Parliament and the Council of 15 February 2006, both referring to the quality of the higher education;
- Recommendation of the European Parliament and the Council of 10 July, 2001 referring the mobility within the Community of students, teachers, trainees etc.;
- The Bologna Declaration of 1999 (referring the harmonization and reform of the higher education systems), etc.

All the above mentioned documents and many others from this area should be subject of deep analysis and consideration (by the countries intending to join the EU) in order to 'catch up' with the ideas placed within these documents. A superficial understanding of the standards and of the conditions stated could lead to incorrect changes in legislation and institutional system and possibly even discrepancies with regard the European course.

Disparities between the conditions in Republic of Macedonia and the European acquis

The quality of higher education and research depends directly on the amount of funds available for their improvement. Increase is registered in the public financing of education in the EU countries. The financing of the universities is about 1.1 % to 1.9% of GDP and this percentage is lower compared to USA and Canada. In order to overcome this situation, additional 150 million EUR annually for have been proposed by the European Commission. It is considered that the minimum of 2% of GDP is needed for the universities in order that they become developed and competitive and take their real role in the 'Europe of knowledge' and in the new concept for the knowledge-based economy[13]. Taking into consideration the fact that there are:

[13] *See: Reform of universities in the Framework of the Lisbon Strategy,* http://europa.eu/legislation_summaries/education_training_youth/lifelong_learning/c11078_en.htm.

- about 3.300 higher education institutions in the EU countries (approximately 4000 in the whole Europe),
- about 13 million students in the EU countries (in the whole Europe about 17 million);
- and about 1.5 million people employed in higher education and research (500.000 of them being teachers):

we can conclude that there is one person (teacher) per 10 students or one researcher per 30 students.

The deficit of funds for higher education is a constant problem in EU as well as in many other countries. Several instruments have been envisaged to help overcoming this situation in the period 2007-2013: the 7th Framework Programme for research and development, the Life-long learning programme, the Competition and Innovations programme, etc. According to European institutions, the 'triangle of knowledge' consists of education, research and innovations. As the universities have the crucial role, they need to be modernized and be strengthened. We should be aware of another fact: 80% of the research work is conducted by universities. Nevertheless, the European Union also calls on the need to include the business sector in the process of funding through incentive programmes for tax releases, for example.

If we look at the figures about the state-of-the-art in the Republic of Macedonia, for comparison, according to the State Statistical Office, in 2007, 2774 persons were registered as employees in the higher education institutions (1671 teacher and 1103 assistants).

2007

Teachers in higher education institutions	1671
Assistants in higher education institutions	1103
TOTAL	2774

2006

	Teachers in higher education institutions	**Full time teachers**	**Assistants in higher education institutions**	**Full time assistants**
State	1500	1359	957	902
Private	139	74	230	159
High Professional Schools	29	8	2	1

2005

	Teachers in higher education institutions	**Full time teachers**	**Assistants in higher education institutions**	**Full time assistants**
State	1518	1355	1056	955
Private	127	41	192	114
High Professional Schools	29	9	/	/

According to the same source (the State Statistical Office), approximately 50.000 students enrol annually in universities (48.368 students enrolled in 2005/2006 and 49.364 in 2004/2005).

Compared with the EU where there is one teacher per 10 students, in the Republic of Macedonia it is almost twice less – one teacher per 18 students.

Budget for Higher Education (from the State budget)

2008	1 787 099 000 Denars	~ 29 million EUR
2007	1 162 627 000 Denars	~ 18,9 million EUR
2006	1 142 004 000 Denars	~ 18,5 million EUR
2005	1 214 238 000 Denars	~ 19,7 million EUR

Funds for Education in general

2001	8 337 000 000 Denars	~ 135 million EUR
2002	8 822 000 000 Denars	~ 144 million EUR
2003	9 434 000 000 Denars	~ 153 million EUR
2004	9 562 000 000 Denars	~ 155 million EUR
2005	9 913 308 000 Denars	~ 161 million EUR

The above tables were provided by the Department for statistics and analysis of the Ministry of education and science (*www.mon.gov.mk*) and by the Ministry of finance (*www.finance.gov.mk*). As we can notice, the State investments in higher education tend to increase and the effort taken by the Government should continue in order to show good results. However, we should keep in mind the following: the number of State universities in the last year has grown twice and it practically means that the increase of the budget has not been made for providing better research conditions: it has been spent on facilities etc. and not on quality improvement of the existing universities. The dispersion might be considered a non-adequate reform step also because of the fact that in a small country as ours, there is no need of so many universities (practically in every town, even the small ones).

Expenditures for science and researches from the State budget are the following:

2006	261 750 000 denars	~ 4 million EUR
2007	265 230 000 denars	~ 4,3 million EUR
2008	358 800 000 denars	~ 5,8 million EUR

The figures given above about the expenditures for science need to be explained: the funds provided for science do not apply only to the research activities, but also the facilities and maintenance of the scientific institutes (which are independent from the universities): these figures do not apply to the latter category, salaries for the employees etc.

Number of researchers by sectors

	1998	1999	2000	2001	2002	2003
TOTAL	3275	3168	3094	2909	2869	2589
Business sector	361	306	241	203	100	67
Government sector	957	1022	1044	809	820	829
Higher education	1957	1840	1809	1897	1949	1693

We can conclude that the situation is alarming having in mind that the number of researchers is decreasing or stagnating during the examined period (for example, 3275 in 1998, 2589 in 2003, etc.[14]

Share of Research and Development (R&D) in the GDP

1998	1999	2000	2001	2002
0.2	0.2	0.2	0.2	0.2

Structure of gross expenditures for research and development in the EU member States as GDP percentage in the period 1999-2004

Country	1999	2000	2001	2002	2003	2004
Sweden	3.65	n.a	4.27	n.a	3.98	3.74
Ireland	1.18	1.13	1.13	1.10	1.16	1.20
Belgium	1.96	2.0	2.11	1.99	1.92	1.93
Germany	2.40	2.45	2.46	2.49	2.52	2.49
Great Britain	1.84	1.84	1.89	1.89	1.88	1.79
Finland	3.21	3.38	3.38	3.43	3.48	3.51
EU-15	1.92	1.94	1.98	1.98	1.97	1.95
France	2.16	2.15	2.20	2.23	2.18	2.16
Austria	1.88	1.91	2.04	2.12	2.19	2.26
Denmark	2.10	2.27	2.40	2.55	2.59	2.61
Netherlands	2.02	1.90	1.81	1.72	1.76	1.77
Spain	0.88	0.91	0.92	0.99	1.05	1.07
Italy	1.04	1.07	1.11	1.16	1.14	1.14
Portugal	0.72	n.a	0.85	0.80	0.78	0.78
Macedonia	0,35	0,44	0,32	0,26	0,22	0,25
Bulgaria	0.57	0.52	0.47	0.49	0.50	0.51
Romania	0.40	0.37	0.39	0.38	0.40	0.40
Croatia	0.98	1.23	1.07	1.12	1.14	1.14

Source: Eurostat

According to some more recent data on research and development investments in the EU-27, the highest percentage in 2006 was registered in Sweden (3.82% of the GDP), followed by Finland (3.45%), Germany (2.51%), Austria (2.45%) and Denmark (2.43%), while the lowest ones are in Cyprus (0.42%), Romania (0.46%), Bulgaria (0.48%) and Slovakia (0.49%).

The highest increases in R&D have been registered in Austria (from 1.91% to 2.45%), in Estonia (from 0.61% to 1.14%) and in Czech Republic (from 1.21% to 1.54%) between 2000 and 2006.[15]

[14] *The tables cited are from the Programme for development of the scientific research until 2010, Ministry of education and science, Skopje 2006 and from www.mon.gov.mk.*

[15] see:*http://epp.eurostat.ec.europa.eu/pls/portal/docs/PAGE/GP_PRD_CAT_PREREL/PGE_CAT_PREREL_YEAR_2008/PGE_CAT_PREREL_YEAR_2008_MONTH_03/9-10032008-EN-BP.PDF*.

Short reference to the relevant Macedonian legal acts. Recommendations

The two essential laws regulating and connecting the area of higher education and scientific research are the Law on higher education and the Law on scientific research. The Statute of the State University 'St. Cyril and Methodius' of Skopje also addresses these issues.

In accordance with the new Statute of the State University 'St. Cyril and Methodius' in Skopje, in the article 299, it is stipulated that the scientific research and applied activities are organized within the University, and that one of the missions of the University is to obtain a certain level of standard and quality of the educational and research process.

According to article 300, the objective of these activities is to develop science and innovation. Both scientific research and its applied activities are developed at the University and in its units, namely in the faculties or in the scientific institutes (article 301). The freedom of scientific, art and professional research, understood as academic freedom, is mentioned in article 302 (basic right of scientists, artists and professionals). The intellectual property rights in this respect are also protected (article 303).

The connections between higher education and scientific research have been also determined in the Law on Scientific Research. Article 3 of this Law states that scientific research is based on its connection with the educational system and on the application of the European standards for recruitment of researchers. Article 15 stipulates that individuals performing scientific research are at State and private universities, scientific institutes, faculties of the Macedonian Academy of Sciences and Arts, etc. As mentioned in article 25, higher education institutions perform fundamental and applied research; research activities performed in these institutions have a tendency to increase the quality of the education as well. The research and applied activities foreseen in the annual plans should make connection between education and research in several related disciplines (article 26).

The annual Plan for scientific research in higher education institutes is made upon the needs for the development of the country, the significance of research for higher education etc. The higher education institutions also have a right to perform professional services as expertises, analysis, clinical services, monitoring etc. for financial compensation (article 26). In order to raise the quality of education and of research, the higher education institution has a right to establish foundations or legal entities and to invest in them. The Law on scientific research also determines issues related to control and evaluation of the quality of scientific research activities. According to article 46 of this Law, the Ministry of education and science monitors the realization of the annual programmes for scientific research of the State universities, public scientific institutes and the scientific excellence centres. The Ministry also controls the spending of the funds from the budget, ensures transparency in the work and ensures access to the scientific information. The subjects performing scientific activities do self-evaluation of the quality of their overall work according to the Statutes and the international standards for evaluation (articles 46 and 47). The funds for scientific research activities are allocated from the State Budget in compliance with the objectives and the priorities defined in the National programme for scientific research and other programmes as well as from international programmes and foundations, local self-government units, legal entities, their own incomes and other sources (article 49). The Ministry also finances, through public announcement, the programmes of the subjects performing scientific research: scientific research programmes and projects, scientific research infrastructure, training of human resources, international scientific cooperation and transfer of knowledge and skills.

The newly adopted Law on higher education seems to reflect the ideas of the Bologna process and the concept of 'integrated university'. In respect with the connection between education and science, article 3 of this Law states that higher education institutions perform fundamental and applied research while providing also higher education, lifelong learning etc. (this article of the Law on higher education corresponds to article 25 of the Law on scientific research). Furthermore, article 18 declares that the university ensures a unique strategic development, creation of standards, norms and rules for ensuring proper organization and performance of higher education and scientific research activities, and outlines the scientific researches. These activities are stipulated in the Law on higher education provisions as well as the activities of the University units (article 20). However, not only higher education institutions can perform scientific research, but also scientific institutes can perform education activities for second and third cycle studies (master and doctoral studies) as article 22 declares. The quality of the higher education is ensured through a system consisting of: accreditation, external evaluation, internal evaluation – self-evaluation and the system of evaluation of the quality of the university teachers and assistants (articles 68-77). The article 81 refers to the issue of financing and states that public universities are financed from the State Budget and from other sources foreseen by the Law and according to the Programme for higher education activities adopted by the Assembly on Government's proposal.

The Law on higher education and the Law on scientific research have been amended recently in order to reach higher level of compliance with the European standards. Nonetheless, many of their provisions, although offering modern solutions, cannot be implemented as the necessary infrastructure is still lacking. It has been appealed many times that before introducing major changes in the education system, it should be given a period of time for adaptation and preparation for accepting these changes; otherwise, some very good ideas for reforming the system will remain just 'declarations on paper'.

The relevant State institutions, especially the Secretariat for European issues, undertook the necessary steps to include the country in the process of EU pre-accession instruments and funds (e.g. IPA programme, one of the solutions to overcome the problem of funding necessary for research projects). It is noticeable that the Government is putting efforts in this direction and that it is also slightly increasing the funds to support higher education and research; nevertheless, more actions need to be undertaken. The economic policy of the Government within the priority determinations included the request for defining the policy of participation of the Government, as well as of the economic sector, in investments in scientific researches. The State needs to undertake concrete steps in order to stimulate the business sector to invest in scientific research through legal and other measures as tax releases, for example.

In conclusion, for more than a decade, higher education and science stagnated. No sufficient attention has been paid by the State in order to improve the situation in the universities and the scientific institutes, the number of researchers was decreasing, the technical support was missing, the State financing was very low and the investments from the business sector lacked. Becoming aware of the fact that without progress in education and science there can be no progress in the society at all, the country undertook reforms in the system and started to increase funding allocated to universities and scientific research and to build capacities in this areas. The country also made some 'pilot' steps in involving the business sector in the investment process in research and improved the legislation. As there is still a long way to the point of reaching the European level in this area, it is of utmost importance that the Government, the universities, the research institutes and the business sector improve the cooperation and coordination and work together on a partnership base in the process of reform and harmonization of the system. The necessary legislation has been adopted, while implementation depends now on the political will of the Government and public authorities.

Georgian National Science Foundation (GNSF): a Key Player in Reforming the S&T Sector

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Following the independence of Georgia, practically all structures and institutions have been changed to some extent. The only sphere that continued its routine without any changes was the system of science management. Moreover, higher education and scientific research institutions were separated from each other within the system. The ***aim*** of the reforms currently implemented by the Georgian Government within the system of education and science is the building of a knowledge-based society. To accomplish this, the system is mandated to assist in the economic development of the country and to contribute to a dynamic upgrading of the quality of education. Advanced and successful systems of science management are characterized by competitive, international peer-review funding mechanisms, a high level of integration between scientific-research and higher education, as well by gradual and consistent increase of R&D funding, mostly targeted towards the strategic development goals of the State. Science reform in Georgia is developing in this very direction.

Among the steps made towards the system reform, a well-deserved place was occupied by GNSF, established in 2005 by Presidential Decree. The ***main objective*** of the Foundation is to organize competitive grants through State funding, and to ensure the conditions for fair and open competition on the basis of individual evaluations by independent international and local peer reviewers, with established principles of transparent and free competition in order to best identify and strengthen the scientific potential of Georgia.

GNSF ***aims*** are to harmonize Georgian science with international standards, to further develop Georgian cultural heritage research, to contribute to the world science achievements, and to further scientific research towards the creation of innovative technologies; to attract and support young scientists and support science popularization.

The Foundation drafted and published the ***Operational Manual*** on the State Competitive Grant System (CGS) in Georgian and English detailing procedures and conditions for those interested in taking part in competitions.

In 2006, for the first time in Georgian history, GNSF organized and held a science grant competition, which stimulated a considerable amount of interest and led to an unprecedented level of activity among local science. More than 2000 project proposals were registered for the competition, 221 were approved (11%), about 10.000 scientists and 150 organizations participated, more than 500 foreign peer reviewers participated in the evaluation of project proposals along with about 150 local experts (2006-2007). It is noteworthy that among the funded projects 26 are collaborative joint projects from scientific-research institutions and universities. This factor indicates a tendency for integration of scientific research within higher education. 757 project proposals were registered for evaluation in 2008.

The competitive project proposals were categorized and registered in 8 scientific directions, including more than 200 sub-directions, as previously determined by the GNSF*:* Information Technologies and Telecommunications' Life Sciences, Mathematics and Mechanics, Natural Sciences, Earth Sciences and Environment, Medical Sciences, Engineering Sciences and High-Tech Materials, Agricultural Sciences.

Following the announcement of the competition, some 1500 scientists were consulted, over 400 requests by phone calls were received and numerous e-mail were answered. The most frequently asked questions were placed on the Foundation's web-site for all to consider.

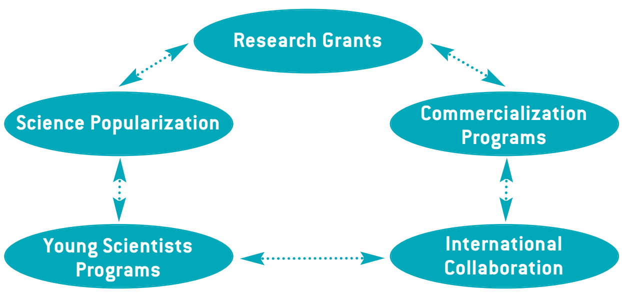
In addition to CGS, GNSF administrates a large number of other State Grants that are aiming at activating the participation of Georgian scientists in the larger international scientific community and further developing scientific infrastructures*.* These competitions include: Short-term Individual Travel Grants; Scientific Equipment Acquisition Grants; Scientific Literature and Periodicals Acquisition Grants for Libraries; Individual Presidential Grants for Young Scientists; Presidential Stipend Program for Young Scientists; Business Partnership Grant and Scholarship program for Young Scientists; Science Lectures in Public Schools and Stipend for NATO SPS Grants and etc.

Most rewarding are the GNSF's collaboration with international science foundations and various institutions including INTAS, CRDF, ISTC, STCU, TACIS, NATO Science Programmes, CNRS and others.

Annually GNSF administers more than 1500 proposals and founds more than 300 of them. And finally, Financing Schemes planned by GNSF for Scientists, including Young Scientists in 2009 are:

- Young Scientists support programme;
- Awards of young scientists publishing in high-rating impact factor journals;
- Individual Presidential grants for young scientists;
- Summer Schools;
- Training for young scientists.

Fig.1. Vision of the GNSF in 2009-2012



The Paradigm of Science Administration and Self-Administration in the Republic of Moldova

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This research presents some key points of the national reform in the field of science and innovations, focusing on various regulations as the Code of Science and Innovations, the legislative acts and other Government's normative acts, adopted to implement State policy in the field of science and innovation. The particularities of combining different elements of administration and self-administration of the science and innovation sphere that are considered optimal by the world science community are equally studied.

The evolution of civilization in post-industrial epoch is conditioned mainly by innovation and science - representing the basic factors for technological progress - that are becoming dominant in a knowledge-based society.

Despite the slogans on traditions and specifics of the state of science and innovation in the Republic of Moldova we ascertain that, in several developed countries, transition periods were overcame following similar models of institutional integration of science and technologies based on the following principles:

a) strict division of labour and continuous increase of the innovation technologies integration;
b) institutional association of science support systems, especially of science administration and scientific expertise;
c) creation of a single informational system and delegation of most informational functions to administration entities;
d) gradual increase and diversification of financial sources for science and innovation area.

Hence, similar administrative paradigms are being used successfully by democratic States for the temporary mobilization of scientific potential in critical situations, assuring:

a) separation of functions between, on the one side administrative entities of science and on the other side, innovation and those of support, auxiliary entities;
b) setting up the infrastructure and effective research entities, detached organizationally from science and innovation administrative and auxiliary entities;
c) focusing the efforts of science and innovation administrative entities on State programmes for monitoring and maintaining links with science and innovation organizations in order to intervene for policy corrections and engage them in the fields of advanced science and technologies.

The reform of science and innovation in the Republic of Moldova started with the adoption of the Code on science and innovation[16] (hereinafter, the Code), which changed completely the science administration and self-administration system, based on:

a) the process of democratization of science and innovation administration;
b) the integration of academic higher education;
c) autonomy of entities within the Academy of Sciences;
d) combining scientific and innovation activities;
e) diversification of science and innovation financing sources and distribution on competitive basis;
f) methodical and scientific coordination by the Academy of Sciences of scientific research activities carried out by different organizations in the field of science and innovation.

According to the Code, the Academy of Sciences represents 'the only public institution of national interest in the field of science and innovation, a plenipotentiary coordinator of scientific and innovation activity, the highest scientific forum of the country, as well as the scientific consultant of the public authorities of the Republic of Moldova'[17], 'represents a juridical person with an autonomous statute, executing its activity on the self administration principles.'[18]

On the basis of the Partnership Agreement with the Government, the Code empowers the Academy of Sciences to develop and implement the State policy in the field of science and innovation for a determined period (4 years). By delegation to the Academy of Sciences of Government competences in the field of science and innovation, the Academy becomes a public institution endowed with competencies of central public authorities in the field of science and innovation[19]. In this quality, the Academy defines the strategy of development in the field of science and innovation; the strategic directions of the activities in the field of science and innovation; the quantum of financing in the field of science and innovation.[20]

Simultaneously, the Partnership Agreement obliges the Government[21]:

- to organize the elaboration of legislative documents on science and innovation and to propose them to the Parliament for examination;
- to create economic mechanisms for stimulating the activity within the field of science and innovation, and the use of the results of these activities;
- to sign intergovernmental agreements on cooperation in the field of science and innovation;
- to support the creation of infrastructures in the field of science and innovation.

[16] Code on Science and Innovation of the Republic of Moldova, nr.259-XV of 15.07.2004, Official Monitor of the Republic of Moldova nr.125-129, art.663 of 30.07.2004.

[17] Idem, art.71, paragraph (1).

[18] Idem, art.71, paragraph (2).

[19] Idem, art.29, paragraph (2).

[20] Idem, art.73.

[21] Government Decision on approval of the Partnership Agreement between the Government and the Academy of Sciences of Moldova for 2005-2008, nr.80 of 28.01.2005, Official Monitor of the Republic of Moldova nr.20-23/133 of 04.02.2005, p.7.

In the conditions of a market economy, which has as pillar the civil society, one of the main problems in the realization of the State policy in the field of science and innovation is the identification of the modality to correlate the self-organization elements with the administrative ones. It is obvious that the General Assembly of the Academy of Sciences which used to include in its membership only academicians and corresponding members, was not a representative of the whole scientific community. This certainly did not correspond to the contemporary requirements and did not assure the participation of the scientific community in the decisional process on the State policy in the field of science and innovation. That is why, the Code stipulates that the supreme administrative body of the Academy of Sciences is the Assembly of the Academy of Sciences (hereinafter, the Assembly), which consists of not only academicians and corresponding members, but also of Doctorate habilitate elected for a period of 4 years (with no more then 2 consecutive mandates) by the scientific divisions of the Academy of Sciences, whose members are elected by PhDs candidates and Doctorate habilitate various field of science.

The total number of elected members of the Assembly which benefit from the same rights as academicians and corresponding members (excepting the right to elect academicians and corresponding members) constitutes 50% from the total number of members of the Assembly. Consequently, the representation of the scientific community is assured, as well as its independence, since the Academy of Sciences is not subordinated to the executive or legislative authorities.

Hence, today, the scientific community, through its representatives in the Assembly, determines independently the activity directions and the modalities of implementing it, assuring the funding of scientific research from the State budget according to the strategic directions in the field of science and innovation. It also assumes, simultaneously the whole responsibility for its results.

Moreover, by including researchers with doctoral degree, respectively PhDs and Doctors, in these important administrative entities, it reinvigorated science and created real premises for the professional development of young scientists.

The President of the Academy of Sciences is elected by the Assembly by a secrete vote for a period of 6 years (but not more than two consecutive mandates), among the full members of the Academy of Sciences. The President is also a member of the Cabinet of Ministers, responsible for its activity to the Assembly and the Government.[22]

In this way, the Code created:

a) the legal base for combining within a public institution (Academy of Sciences of Moldova), State administration elements in the field of science and innovation (the Supreme Council for Science and Technological Development and its scientific divisions) with those of self-

[22] Code on Science and Innovation of the Republic of Moldova, no. 259-XV of 15.07.2004, Official Monitor no. 125-129 art. 663 of 30.07.2004, art. 82, par. 1

administration in this field through the representative bodies of the scientific community (meetings of scientific researchers grouped on distinctive fields of science, the Assembly);

b) a balanced system of entities that allows:
- to make research;
- to monitor severely the level of activity carried out by science and innovation organizations and the level of training of the scientific staff;
- to implement the results of scientific research in real terms and in optimal conditions, according to intellectual property rights.

Additionally, in accordance with the Code, a series of normative acts were adopted in order to:

a) ensure the concentration of intellectual, material and financial resources for efficient scientific research with an aim to accelerate the solving of striking economic, social, ecologic and cultural problems and to optimize the science and innovation infrastructures[23];

b) support technology transfer of scientific results activities by exemption from payment of customs taxes on imported technological equipment, installations and other goods[24];

c) stimulate innovation and technology transfer activities aimed at translating results of scientific research and innovation into products, services, new or improved processes, by regulating the legal framework of organization and functioning of science and technology parks and innovation incubators[25].

The level of professional activity of scientists can be efficiently controlled by the publication system in different fields of science and innovation, founded by the entities of scientific community which assure the independent and permanent expertise of scientific publications.

An indispensable function of professional self-administered entities within the scientific community consists in its mandatory engagement in the activity of reproduction and training of scientific personnel, beginning with graduates, master students, PhDs and ending with the post-docs. This presumes coordination and transfer of the reforms made in the scientific community to the higher education system. This implies, on the one hand, assuring the independence of entities which offer scientific degrees and titles, and accredit science and innovation institutions, and, on the other hand, engaging into this activity outstanding representatives of the scientific community, higher education system and suppliers of scientific products and services (State entities, commercial societies and civil society).

Despite different types of barriers, science and innovation organizations were submitted to the accreditation process by the National Council for Accreditation and Attestation, by which they have demonstrated their competitiveness and capacity to efficiently use the financial

[23] Government Decision on optimisation measurement of infrastructure of scientific and innovation field nr. 1326 of 14.12.2005, Official Monitor of Republic of Moldova nr. 168-171/1406 of 16.12.2005.

[24] Fiscal Code nr.1163 of 24.04.97, Official Monitor of Republic of Moldova nr. 62 art.522, 18.09.1997, art.491, art.103 paragraph (1) p.27).

[25] Law on Science and Technology Parks and Innovation Incubators nr. 138-XVI of 21.06.2007, Official Monitor of the Republic of Moldova, nr. 107-111/476 of 27.07.2007.

resources allocated from the State budget. As a result, those who obtained the certificate of accreditation can become[26]:

a) an institutional member of the Academy of Sciences, which means complete financial support of its activities in the field of science and innovation (from the State budget);
b) a profile member of the Academy of Sciences, which implies financial support from the State budget offered on competitive basis for basic research and partial financial support from the State budget offered on competitive basis for applied research; priority is given to research projects which are financed from own non-budgetary resources, as well as from other resources;
c) the statute of affiliated member of the Academy of Sciences, that opens the possibility to participate in open calls for projects and programmes with State financial support of up to 40% of the total cost of the project which passed the threshold, with the condition of having additional financial sources.

Ensuring the efficient interaction of all administrative entities of the scientific community must result in the development of scientific activity indicators that should be accessible, transparent and informative; these indicators will further reflect the progress in the field of science and innovation, and should be at the basis of science and innovation policy elaboration.

The implementation of the Code's provisions and the reforms carried out in the field of science and innovation have contributed to the increase of visibility of the Academy of Sciences of Moldova at international level. In the framework of the International Conference of the Academies of Eastern and South Eastern Europe on 'Global Science and National Policies: the Role of Academies', organized in Chisinau with the support of UNESCO and the International Council for Science (ICSU), 4-5 May 2007, it was recognized the uniqueness of the Moldavian model of science administration, and was recommended the implementation of this model in similar situations.

The Republic of Moldova assures the continuity of science and innovation policy promoted by the Code, by sustaining the strengthening of the innovative capacities and technological modernization of the country by means of[27]:

a) setting up and promoting efficient mechanisms for assimilation of advanced technology;
b) optimizing the field of science and innovation by creating scientific clusters and platforms, and by guiding the intellectual and technical-experimental personnel in the process of implementation of national priorities;
c) consolidating the technical and material base of science and innovation organizations ;
d) consolidating the national scientific research system, also by stimulating the participation of scientific organizations in research and development (R&D) activities and their participation into major European and international programmes (FP7, EUREKA, COST, CRDF, STCU);

[26] Code on Science and Innovation of the Republic of Moldova, nr. 259-XV of 15.07.2004, Official Monitor nr. 125-129 art. 663 of 30.07.2004, art. 100, par. 5.

[27] Law No. 295 of 21.12.2007 on the adoption of the National Development Strategy for 2008-2011, Official Monitor of the Republic of Moldova nr. 18-20/57 of 29.10.2008. Annex comp. 3.4.1.

e) promoting research and innovation by means of scientific and technological parks and innovation incubators and applying the results of scientific research, as well as national and foreign technologies into economic activity;
f) introducing innovation indicators in the national statistics system;
g) promoting access to financial resources in technology intensive fields, especially by means of alternative financial instruments (e.g. 'angels investors', 'seminal capital', micro-credits);
h) stabilizing and developing human scientific, innovative and managerial potential, by creating juridical and economic mechanisms to boost motivation of researchers and innovative activities, depending on the results obtained in realization of national priorities;
i) sustaining and creating local academic networks and professional associations for the implementation of local and regional ICT research;
j) creating an open national database of science and innovation organizations and scientific researchers.

The real scientific achievements of the Academies of sciences that have taken over the autochthonous model of science and innovation prove us that the decision was correct and timely. However, as this is a dynamic and continuous process, the development in the field of science and innovation requires permanent adjustments. Thus, in the context of the reform of the central public administration and summing up experiences acquired during Code's implementation, it was ascertained that, in order to increase the effectiveness of the administration of this field, it is vital to operate modifications and additions in legislative acts that:
a) would assure unconditional exemption from payment of income taxes and VAT for accredited science and innovation organizations[28];
b) would assure unconditional exemption from payment of customs taxes for imported goods and services for science and innovation organizations[29];
c) would guarantee[30] the following:
- supplementing the academic body with young researchers by means of: reducing the total number of full and corresponding members; opening access to Doctorate holders to leading functions of the Academy of Sciences, including the scientific divisions;
- raising the effectiveness of activities and responsibilities of the full and corresponding members;
- optimizing the scientific divisions by modifying their composition and decreasing their number;
- liquidating the intermediary ring of administration by transferring the responsibilities of scientific divisions administration to the vice-presidents of the Academy of Sciences.

[28] Fiscal Code nr. 1163 of 24.04.97, Official Monitor of the Republic of Moldova nr. 62, art. 522, 18.09.1997, art. 49 1, art. 103 par. (1) p. 27.

[29] Law on customs taxes No. 1380 of 29.11.97, Official Monitor of the Republic of Moldova nr. 40-41/286, 07.05.1998, art. 28 letter r). Protocol to Convention regarding the import of publications with instructive, scientific and cultural character from 01.03.1977, International treaties, 2001, Vol. 26, pg. 154

[30] Code on Science and Innovation of the Republic of Moldova nr. 259-XV from 15.07.2004, Official Monitor no. 125-129 article 663 of 30.07.2004 art. 76-78, 83-85, 87.

CHAPTER III

Developing a Knowledge-Based Economy

Towards a New Economy in the Republic of Belarus

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Main stages of the formation of a modern Belarusian economy

There are three periods in modern history of Belarusian economy from 1996 till present. These periods can be conventionally called as follows: 1996 – 2000: a stabilization period; 2001 – 2005: a period of economic development; and the current period (since 2006): a period characterized by a shift towards an innovative economic development.

During the stabilization period a model of socially-oriented market economy with a gradual progressive entrance of all its spheres into a market economic environment was realized. After a decrease in gross domestic product by 35% in 1995 (to the level of gross domestic product of 1990); industrial production, by 41%; and consumer goods production, by 40% - the economic stabilization task was set and successfully completed. During the period of 1996 – 2000 the gross domestic product (GDP) increased by 36% to reach 88% of the pre-depression level. Industrial output increased by 65% to exceed the level of 1995 by 1%. Furthermore, the actual population income reached 106% compared to the beginning of the stabilization period.

However, the innovative activity and production modernization were not and could not be the main vector of the production policy of this period. The growth of investments to the basic capital amounted to 25.5% as compared to 1995, i.e. about 2 times less than those rates, which they had been falling with in 1990 – 1995 (61%). The main task for this period was to avoid economic collapse and to ensure economic security in the country. As a result, Belarus was the first of all CIS countries to retain the industrial output level of 1990. During the period of 1996-2007 the gross domestic product of the country experienced increase by 2.3, production output – by 3, investments to the basic capital – by 4.7. The population was provided with workplaces, unemployment rate was reduced, external trade diversification was obtained and people's welfare was increased.

During the next 5 years (2001-2005) a course for economic growth and macroeconomic stabilization was set. This course inferred a drastic reduction of the inflation rate and monetary policy stabilization. These were intended to make a foundation for investment in innovative activity not only at the expense of target-oriented State-run programmes and budget capital, but also with the involvement of private and foreign investors. These were essential but not sufficient prerequisites. Many aspects of tax legislation and pricing had yet to be reconsidered. New elements of innovative infrastructure had also to be created. The research intensity of the Belarusian gross domestic product was about 0.7%; the quota of the budget expenditure for science in the total consolidated budget expenditures decreased from 1.12% in 2001 to 0.81% in 2005 and to 0.78 in 2006 (in OECD countries this figure is 2.5-3.5%, in USA, France, Germany, Great Britain). But despite those conditions, with the help of intensive production factors (labour productivity, scientific-technical progress, production modernization) more than 90% increase of gross domestic product in branches of national economy was provided, which is much higher than a corresponding figure during the Soviet period of Belarusian economy.

At present the 'growth persistence' and approved methods of mobilization management allow to complete the main predicted plan parameters of the Programme of social-economic development of the Republic of Belarus for 2006-2010 (hereinafter referred to as 'Programme'). The completion of the most significant long-range plan parameters for 2007 (Table 1) was in general a contributory factor for reaching the level, determined by this Programme, what was due to the improvement in almost all basic parameters.

Table 1: Dynamics of Belarusian Economy Development in 2007

Value	Growth by 2006 , %
Gross domestic product	108.2
Production output	108.5
Agriculture production output	104.1
Consumer goods production	108.2
Total area quarterage built	114.1
Investments into the basic capital	115.1
Foreign trade volume	125.9
including export	224.5
international service volume	134.4
Actual population income	115.0

It is to be noted that economic growth in 2006-2007 was accompanied by a noticeable reduction of the gross domestic product energy consumption, which is vital concerning the price increase of the imported energy products.

In the investment sphere, the growth ratio of the investments into the basic capital in 2007 were 152.2% compared to the year 2005 (planned value – 133.4%). The completion of the Programme's tasks in the investment sphere in advance enabled to retain and to multiply considerably the country's investment potential of pre-depression level by 1.4, as compared to the level of 1990.

The production growth in the main branches of economy made it possible to fulfill pre-planned parameters of the population welfare increase Programme: during 2006-2007, actual earnings of the population increased by 28.4%, actual population income, by 35.1%, retail volume, by 35.4%.

In foreign economic activity, in 2006-2007 foreign trade volume increased by 61.2%, including: export, by 52.1; import, by 70.4% (117.2-119.4% planned). This resulted in negative balance of foreign trade, 2.7 billions of dollars. This balance was compensated for by external credits: during the year of 2007 the country's external public debt experienced increase by 1499 millions of dollars to reach 2.3 billions of dollars as of January 1, 2008, which is equal to 5.2% of gross domestic product, as compared to 2.3% of gross domestic product as of January 1, 2007. The external debt increased and reached 12.9 billions of dollars (an increase by 91.1%).

Following the results of national economy activity, the Republic of Belarus managed to keep a positive dynamic of production and investment activity in the main branches of economy.

Stable growth strategy provides means for the improvement of the country's prestige in a world economic community. According to the United Nations Development Programme Report on Human Development in 2007, Belarus increased Human Development Index to become for the first time a country with a high level of human development. The country moved from the 67th to the 64th place as compared to the previous year. No other CIS country had a better result. The Russian Federation is on the 67th place, Kazakhstan – 73th, Ukraine - 76th.

According to the UNCTAD 'Developing Countries in International Trade 2007 – Trade and Development Index' Report, the Republic of Belarus is on the 57th place in the world and the country is considered one of the most dynamic CIS countries. As indicated in the Report, among the strongest Belarusian points are high rate of economic and social welfare as well as current growth of foreign trade volume. With these figures Belarus occupies the 34th place in the world and keeps forward all the CIS countries.

As stated in the UN 'Analysis and Prognosis of the World Economy in 2008' report, Belarus traditionally has a low unemployment rate – about 1%. This is much lower than a corresponding value in the Russian Federation (6.1%), Ukraine (7%) and in EC countries (with average unemployment rate of 5.4%, the highest being in Slovakia – 11.4%). In spite of the price increase for energy products country consumer price index in Belarus kept lower than the average one in CIS countries. It was better than in oil-exporting countries (Russia, Azerbaijan, and Uzbekistan) and equal to Kazakhstan's index.

As per UNCTAD Report on world investments of the year 2007, Belarus is labeled to be a country with high potential of attraction of direct foreign investments and is on the 47th place in the UNCTAD rating. International rating agency Standard&Poor's attributed to Belarus a value of sovereign credit rating: long-term in foreign exchange B+, short-term in foreign exchange B, long-term in native currency BB, short-term in native currency.

In the course of the rating process, the agency determined key factors governing the Belarus rating to the fullest extent: stably high rates of economy growth, low level of State debt, fundamental economical potential of the country, progress in fight against inflation, high for CIS countries standard of living and presence of experience force. It is emphasized that the economy of Belarus represents one of the largest economies among the countries of B+ category.

Innovation-based development is a State priority of Belarus

Now is the time for Belarus to actualize the third stage of socially oriented economic model development. For the first time the necessity of transition from extensive growth to intensive development was put as the primary objective in June 2004 on the standing seminar of high-level personnel of State and local authority on innovation politics, where President of the Republic of Belarus, A.G. Lukashenko, put innovative activities as one of the main priorities of Belarusian economy development. The development of innovative activities was fixed as one of the main programme directive of the Programme of social and economic development of the Republic of Belarus for the years 2006-2010, as well as in resolutions of the 1st Congress of Scientists of the Republic of Belarus. Thus the country has come to a new stage or, in philosophers' words, to a new paradigm: from economic growth to economic and social development when scientific and innovation activity becomes not 'one of' but the major system-building factor of public development. It fully corresponds to the modern tendencies of the world economy and primarily to the processes of 'new economy' establishment. Moreover, it suggests creating a self-developing system where an intensive flow of innovation production and a high degree of sensibility to them from the public production side is the condition of its safe existence.

Like all perfect models to be realized this model requires massive efforts. It is developed in a difficult external economic situation due to the growth of world prices for energy sources and food and due to Russia's entry into WTO following Ukraine. According to scientists' opinion new decisive and effective measures should be taken in such a situation to provide new quality of economic development.

Development is an innovation process which is based on scientific and technical activity. Management by objectives is regarded as a basic mechanism of research and technology management in business practice of our country. The Government Programme of Innovation Development in the Republic of Belarus for the period of 2007 – 2010 that was ratified by the President in 2007 has become a considerable step in this direction, and it implies the realization of 1302 new projects. The programme implementation will result in more than 100 new enterprises set up, 3686 manufacturing departments established, 609 operating enterprises modernized grounding on the introduction of 888 advanced technologies. To implement the programme it is planned to use more than 1000 domestic and about three hundred foreign technologies. Thus about 70% of the projects will be realized on the basis of Belorussian scientists' developments.

According to the Implementation Plan of the Programme 728 significant projects were carried out in 2007 including 134 projects on the establishment of new manufacturing departments and 594 projects on the modernization of the operating ones. 20 enterprises with important manufacturing departments, 57 new manufacturing departments were set in operation within a year. 118 manufacturing departments of the operating enterprises were modernized.

The second basic element of innovation activity system is the concentration of the country's intellectual and financial potential on the priorities of social and economic development peculiar to our country. The list of such priorities is fixed in the Programme of Social and Economic Development of Belarus every five years. All scientific organizations in Belarus, in their turn[31],

[31] There are about 300 scientific organizations and 30000 researchers in Belarus.

work strictly within the priorities of research and technology activity that were first approved in 2005 respectively by the Cabinet Council and the President of the Republic of Belarus. It means that in practice scientific work is built on government order.

Research and technology activity is organized within 11 State complex target research and technology programmes (SCTRTP) which are the third most important element of the innovation system. These programmes combine practically all State research programmes, State scientific and technical programmes as well as assignments of presidential, State economic, social, sectoral and regional scientific and technical programmes, and programmes of the Russia-Belarus Union State.

At present SCTRTP include 58 State programmes as their sections. The programme managers are top executives of the country ranking from Vice-premier to Minister who are in charge of coordination councils on each of 11 programmes. Only in 2007 more than 15 sessions of the coordination councils under the chairmanship of First Deputy Prime-Minister and Deputy Prime-Ministers of the Republic of Belarus were held.

Such a scheme proves the effectiveness of using both State growing expenses on science and real economy customers' own funds. Continuous extension of research and development scope makes it possible for Belarus to keep the research and development value (including sci-tech service value) regarding gross domestic product at the level of about 0,7% when the research intensity index determined by the OECD technique was 0,975% in 2007 with an increase by 0,31 percentage point by 2006 (0,66%). In 2007 expenses connected with research and development works (in comparable prices) have grown by 59,3% against 2006. In the same time, the contribution of research and development works funded by enterprises' own funds has increased to 38,6% of the inner costs overall volume in 2007 (in 2006 – 9,8%). Of the overall research financing volume, fundamental research got 15,8% and application study and developments - 84,2% of the allocated funds.

The Governmental Programme of Innovation Development Funding is one of the furthest-reaching and most resource-significant investment projects of the country in the sphere of the national economy modernization. In 2007 about 8% of the country's consolidated budget income from all financial sources was directed to fulfill the program targets. In the overall budget volume, the State budget funds constitute 30,8%; foreign investments, 22%; organizations' own funds, 4%; credit and borrowed funds, 19% (local budgets funds, 4%; other sources, 1,6%).

The intensive development of the scientific sector has been growing as an effective factor advancing innovations and new technologies: in 2007, 27,3% more innovation products were shipped than in 2006. The competitive power of Belorussian innovation products is proved by its high export ratio in 2007 – 73,1% while 46,5% of innovation products was exported to the CIS countries and 53,5% to far-abroad countries. In the section of industry related fields, the dominant position is taken by manufactures of fuel industry, mechanic engineering and metal work, chemical and petrochemical industry, iron industry that produce and sell as a whole 90,8% of the innovation product. Mechanic engineering and metal work are the chief fields in production and shipment of innovation products with the share of 45,4%.

On the whole Belarus created 375 advanced technologies including 293 new ones within the country, 76 new ones abroad and 6 brand new technologies. For the last year there were applications for about three thousand patents for inventions, useful models and industrial samples. There were given 2,4 thousand patents including more than two hundred (231) documents of title of other countries.

Role of the National Academy of Sciences of Belarus in the innovative development of the country

In order to redirect its activity on resolving the problems of the innovative development of the country the National Academy of Sciences of Belarus in 2007 accomplished its organizational reformation and has turned into a powerful research-and-production and scientific-educational organization. At the present time there are five research-and-production centres in the Academy which specialize in agriculture. In 2007, 2 scientific centres (one specialized in material sciences and the other in bio resources), as well as State research-and-production associations, with specialization in chemical synthesis and biotechnologies, chemical products and technologies, have been created. A number of other structural transformations have been carried out.

We have directed our steps toward formation and realization of major long-term system projects, which allow us to form entire new branches of the sixth technological mode. We mean realization of the State programmes concerning light-emitting diode equipment, solar electroenergetics, development of micro- and optoelectronics, nanotechnologies, laser-optical technology, biotechnologies, improvement of heat processes and energy saving, expansion of CALS-technologies. These goals are beyond the scope of the State program of innovative development, which ends in 2010, and should be achieved in medium- to long-term.

In particular the Academy of Sciences suggests the creation of powerful complexes producing super-bright light-emitting diodes, which lack in Belarus. Today these products are produced in the USA, Taiwan and Japan. According to the estimates in the nearest 5-10 years incandescent lamps and partially luminescent lamps will be replaced by light-emitting-diode lamps, which are characterized by longer working life / lifetime and higher degree of power efficiency.

In 2007 the cost of therapeutic laser and light-emitting-diode equipment developed in the Academy of Sciences was 5,5 times bigger than the amount of funding allocated for research from the State budget. There has been developed light-emitting-diode backlight for liquid-crystal displays, other light-emitting-diode equipment for rail transport, underground railway stations, road machinery, defense needs.

Today it is already possible to illustrate the practical use in industry of the research results in the sphere of nano-materials and nanotechnologies. The creation of super hard plates, cutting tool, abrasive material has made it possible for the Belarusian industry to master the use of more than 300 items (of instrument/equipment), and 200 additional items will be actively used by 2009. New methods of producing membranes of high performance only when used to process water from surface sources require capital expenditures less by 6 times in comparison with traditional technology and less by 2,5 times in comparison with current expenditure. Only a few companies in Germany, Japan and USA possess these nanotechnologies.

Belarusian scientists successfully develop the newest chemical-enzymatic approaches towards the production of pharmaceutically important modified nucleosides and nucleotides. These are the most progressive technologies in the word. There have been produced anti-leukemia drugs, which are 3-4 times cheaper than their import analogues and are of better quality. Genetically engineered strains have been created – ferment hyper-producers engaged in the new biotechnologies.

Scientists from the National Academy of Sciences of Belarus assume that the modern phase of the economic development require more active introduction of the new forms of national economy governing at the expense of drastic expansion of innovative technologies. Today we need new approaches to production to order just in time with the appropriate (after-sales) service and replace by new modifications. In order to do that, we need strict and powerful system of market monitoring and production management with the help of information technologies. These are the so-called 'CALS' technologies which encompass the processes of designing, procurement, production, sales and after-sale service.

It is planned to complete the transition to electronic services of organizations in the country by 2013. In 2015 the majority of governmental services shall become available from all locations 24 hours 7 days a week. The Ministry of Emergency Situations is planning to solve main problems of emergency on the basis of modern geospatial data. It is also scheduled to complete the development of a series of digital maps and applied tasks solving system for State Committee on Property Management. Universal issues of automation of banking, customs and tax services are to be resolved.

A prototype of tele-medical system of Minsk City has been created in the sphere of domestic medicine. Doctors had the opportunity to perform a quick cardio-diagnostics and patients – to get high quality consultations. And it is not a single practice. The central computational node of the personal cluster 'SKIF-TRIADA' has been created and tested on the basis of the 2nd anti-tuberculosis dispensary and 8 polyclinics of the capital.

The scientists of the Academy assume that one of the directions of the new strategy in the field of micro- and radio electronics may imply the refusal to maintain the entire production cycle of integrated circuits in our country. The main thing is to know the designing technologies of microelectronics. Therefore it is necessary to create Design Centers which will be responsible for designing the most complicated items, and separate orders for manufacturing may be placed in South Eastern Asia and even in the EU where there are plenty of modern manufacturing capacities.

At present the scientists of the Academy together with the Government are about to complete the development of large-scale governmental programmes on initiation of a world class biotechnical production, space industry, nuclear power engineering, facilitation of technological breakthrough in the field of chemical industry and science intensive mechanical engineering. Much attention is paid by Belarusian science and the Academy of Sciences to the stimulation of power efficiency of the economy and ensuring energy security.

Forms of international scientific and technical cooperation

Today living in the epoch of global economy it is impossible to resolve questions of innovative development individually. The list of the countries which are among Belarusian international scientific and technical contacts is continually increasing. The first to mention is the development of cooperation with the CIS countries.

For example, 16 models of cluster supercomputers with peak performance ranging from tens of billions to several trillions of operations in a second can be stated as a result of the realization of the union programme SKIF (with the Russian Federation). Advanced technologies on applying and processing space data have been developed within the union program 'Kosmos' with the participation of more than 20 Belarusian and 30 Russian organizations.

Last year started its implementation the scientific and technical programme of the Union State 'Development and Application of Hardware-Software Utilities on Grid-technologies of the High-performance Supercomputing Systems of the SKIF family for 2007-2010'. It is planned to create a Grid network which would include clusters and separate servers of Belarusian and Russian Academies of Sciences. The development of the Union State programme 'Intelligent IT and systems' is scheduled for the years of 2008-2011. The current modernization of the BASNET network will provide the opportunity to manage traffic from 1 gigabyte in a second and more, which will facilitate the development of Grid-technologies and broaden the implementation of tele-medical technologies. The intended connection to all-European scientific network GEANT will secure the authorized participation of Belarus in international scientific projects.

It should be mentioned that the results of Belarusian scientists' research are worldwide famous. More than 16 thousand publications by Belarusian researchers have been collected in one of the most authoritative databases, 'Web of Science' (Philadelphia, USA) for the period of 1993-2006 which comprises about 3 articles a day. 55% of the total amount belongs to the scientists from the Academy of Sciences. The list of the magazines which published the articles of Belarusian scientists, recorded in the given database, holds 1700 names. Scientists from other countries refer to the works of Belarusian researchers (3,8 thousand times a year-which is more than 10 times a day). Recently the 'citation index' of Belarusian scientists has practically reached the one of the Russian scientists' and is gradually approaching the world level.

The liaisons between member States of European Union, Asian and African countries have recently gained a new impetus, and the prospects of scientific and technical cooperation with Iran and Venezuela have been considerable widened. The cooperation with international organizations UNIDO, UNDP, IAEA is rapidly progressing. International activity of the Academy of Science organizations includes more than 76 States. Annually scientific organizations of the National Academy of Sciences of Belarus realize about 500 international projects and contracts with foreign partners from Russia, China, Korea, France, Germany, USA, Ukraine, Austria, Sweden, Finland, Poland, India etc.

In 2007, 423 projects were financed within the bounds of joint international contests of the Belarusian Republican Fund of Fundamental Research and international and foreign organizations and funds. Scientists from 25 countries acted as partners of Belarusian research teams in BRFFR projects.

As demonstrated above the National Academy of Science aims at implementing a large-scale system of projects which cover the entire innovative cycle from scientific research to industrial development of new production, new manufactures and branches. I am convinced that international cooperation between the scientists of our countries should be orientated towards such complex projects.

I consider that it is necessary to draw serious attention to the development of legal and financial systems of scientists' cooperation which would form the basis for the creation of the integrated scientific, technical and educational area between the States of the CIS. It is an extremely important issue for the development of the competitiveness of the economies of our countries. Currently applied rules and procedures of international cooperation are very complicated and bureaucratized. What specifically is to be done?

I suppose that the first task to be solved is the definition of the priorities of the scientific and technical activity of common interest. The documents ratifying the corresponding priorities of the Republic of Belarus at Presidential and Governmental level are suggested to form the basis for discussion. The results of the analysis demonstrate that the priority lists of our countries include more common points rather than divergences. It is necessary to define the directions where joint effort will have the best results favorable for all countries.

In particular, the scientists of the Republic of Belarus possess a substantial groundwork and are interested in the development of multilateral cooperation in such directions as IT and supercomputer techniques, biotechnologies, nano-materials and nanotechnologies, laser physics, hydrogen energy and development of energy complex on the whole, creation of transport and logistics systems, science intensive components of the machine building complex.

The next important issue is the harmonization of the juridical sphere governing the circulation and transfer of intellectual property objects. All member States of CIS (Community of Independent States) are forming the institutional basis of the civilized market relations, where a product of intellectual property is regarded as a commodity of full value. But the development of this process is on different levels, so our scientists are to cooperate regarding different legislative requirements of a particular country which complicates their task. That is why it is necessary to resolve the problem by creating a Model Agreement on circulation and transfer of the intellectual property rights, covering at the outset bilateral and later multilateral agreements on scientific and technical cooperation.

Simultaneously, we should discuss the problem of improving forms of joint research funding. It is possible to define several promissory directions. First of all it is the creation of a target scientific innovative fund of the CIS countries, which would form a reliable basis for scientific and technical integration at the expense of creation of economic mechanism of motivation and allocation of revenues from the realization of science intensive innovative projects.

Secondly, it is necessary to work out the problem of establishing an international venture fund for financing innovative projects of the CIS-countries on commercial basis.

Thirdly, a great advantage lies in the enhancement of cooperation within international programmes of our countries' fundamental research funds. And the basic reserve is the transition from bilateral to multilateral projects being carried out in the interests of several countries.

Finally, it is necessary to form a system of planning and organization of using multi-access centers aiming at creating large inter-State scientific centers. Every CIS country possesses particular scientific potential, having sometimes unique material and technical basis and there is no need to duplicate it in each of the CIS States. The question is how to rationalize its utilization.

At the same time we should look for new forms of collaboration. In particular, I suggest that we discuss the issue of assigning to some sub-divisions of scientific institutions of the Academy of Sciences the status of 'joint scientific laboratories', conducting research into priority directions for both countries and providing joint funding for such research.

It is necessary to intensify the activity on the establishment of joint innovative manufacturing departments on the territory of our countries, including industrial park areas and other innovative infrastructures on the basis of academic development completion.

The activity concerning join participation in international projects with third countries and scientific centers should be more significant, in particular concerning national and international grants, first of all in contests held by BRFFR, RFFR and RHSF, the 7th Framework Programme of the European Union, the International scientific and technical center, the Scientific Committee of NATO, IAEA, UNESCO etc. It is necessary to develop common positions in international events concerning questions of the development of scientific and technical sphere of the both countries as well as all CIS countries in general.

All listed and many other forms of cooperation should aim at the creation of the common scientific innovative and educational area within our countries, which components are joint laboratories and multi-access centers, the participation of foreign scientists in international and national scientific and technical projects, mutual internships and special educational programmes on preparing specialists for the sixth technological structure.

It is a common knowledge that science is international by nature. As far as I can see our task is to make it international in practice within our own countries and CIS in general.

Science - Education - Innovation: Basis for Development of Scientific Centres and State Economy in the Russian Federation

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The topic 'Developing a knowledge-based economy' is very close to the activities of our Institute, as the triad Science-Education-Innovation is in the key concept of the Institute development. So, on the basis of JINR, as a good example of such triad, I prepared my contribution below.

In general, it should be noted, that science and technology continue to advance at a very rapid rate in the world, and discussion of the issues that arise from these developments is highly important.

Firstly, let me very briefly give you general information about our international centre. The Institute was established in March 1956 through a Convention signed by the Plenipotentiaries of the governments of the JINR member States (at that time 12 States).

The Institute was created in order to unify the intellectual and material potential of the member States in order to study the fundamental properties of matter. The year 1992 (after the disintegration of the Soviet Union) marked a new development stage in the history of the Institute. Today JINR overlaps 23 countries on a continuing basis, including 18 full member States and 5 associated members: Germany, Hungary, Italy, the Republic of South Africa and recently, Serbia.

Our international collaboration is very broad and includes nearly 700 research centres and universities in more than 60 countries of the world. I would like to stress, that the model of an international scientific centre established by our founders – outstanding scientists from Russia and Member States – turned out to be very efficient and viable: the ideas and goals which formed the basis for JINR activities in the mid-1950s have survived the test of time, including political shocks and the severe economic crisis of the 1990s.

Our Institute has always functioned according to specific plans. After the hard economic times of the 90s of the past century, the situation in the Institute stabilized and the Directorate of JINR, together with its distinguished international Scientific Council, proceeded already to developing long-range plans and advanced programmes.

In 2003 a seven-year programme was worked out. It completes next year, so we have started to work on the preparation of a new 7-year plan. And finally, in 2006, the Committee of Plenipotentiaries approved the road map – a plan for the strategic development of JINR for a future perspective in the long run, up to 2017.

The triad science-education-innovation serves the basis for these long-term programmes. We consider that today a well-functioning interface between these three components is extremely important to reap the economic and social benefits from public and private investments in research.

Obviously, fundamental science for our Institute is the primary component of this triad. At the same time, we are giving a special attention to the development of our innovation activities in order to bring them to the commercial level. Together with its main purpose, the well-developed innovation technologies, would also promote the economic conditions for fundamental science. The role of the educational programme is continuously enhancing at JINR. Great attention we are paying to the young staff programme in Dubna, and at our Institute, in particular.

Among the most ambitious fundamental physics tasks there are issues of the origin of the Universe (the Big Bang), the structure of matter, the nature of mass in particles, nucleosynthesis, etc. Today JINR is the world leader in the super-heavy elements synthesis; the D. Mendeleev table has been lately complemented with a number of new elements synthesized at JINR. 'Where are the limits of this table?' is a fundamental question waiting for an answer as well. The so-called 'Standard Model' has not been fully 'filled in' yet either. Furthemore, physicists hope to be more successful and discover the so-called 'Higgs boson' particle that provides mass to particles. We hope the answer to this issue would come from LHC-2008. I gave these examples in order to underline that while searching the answers on these ambitious fundamental tasks, scientists, in parallel, are developing science-driven high techs programmes, which are necessary for society.

The triad 'science-education-innovation' known as the Lavrentiev-Flerov triad establishes a solid system of scientific-economic ties and is the basis for sustainable development of any research institution. The experience of the last two decades has shown that only those centres and organizations that based their activities on this three-component ground, have strongly remained on their feet. The Joint Institute for Nuclear Research (JINR) in Dubna proves this thesis brightly: after the fall of the socialist system, the Institute preserved the world standard of research, taking part in large-scale projects and experiments both in and out of Dubna, maintaining contact with traditional partners, and involving the advantageous cooperation of new participants.

Fundamental science is not only a highly important prerequisite to provide successful development in the global technological evolution of the 21st century. It should be stressed that it has also become an independent factor of a driving force as it creates intellectual resources for a new basis of the technological, economical and social development. For example, radioactivity studies – a fundamental scientific problem – have brought about the evolution of a whole bunch of branches of theoretical and experimental physics. Their development has led to new industries: precision engineering, electronic industry, atomic engineering, atomic energy industry and many others.

The basis for fundamental science has always been the so-called framework projects (based on large basic experimental facilities) whose development has created the grounds to establish both new scientific trends and new technologies. JINR has a large and unique park of basic facilities – accelerators and reactor – which are now under the upgrade programme by the year 2010. Very large fundamental research and applied studies are implementing on these machines. Our young generation, first of all students from our University Centre, regularly get trained and are involved in practical experimental projects on these facilities.

The Joint Institute has also a broad experience in finding solutions to staff issues. The Institute has been training young staff for JINR on its own for a long time. They are the very young scientists and specialists it needs. The University Centre of the Joint Institute for Nuclear Research appoints University Chairs coming from the most prestigious Russian higher education institutions and higher education institutions of member States and together with the principal JINR Chairs at Dubna University, trains specialists in scientific research, engineer support of the modern technological process, management of science and innovative manufacturing.

The idea that science in Russia must be part of the market economy was discussed by scientific leaders and State officials even in the early 1990s. Actually at that time already it was understood that special structures should be established around large scientific centres or, in other words, what we call today special economic zones (SEZ). They have been established, and we have taken the experience of our predecessors as the basis for our work at the Joint Institute.

Let me remind you that in 2005 the Government of the Russian Federation (RF) adopted a resolution on the establishment of six Special Economic Zones on the territory of the Russian Federation. The status of a special economic zone of the technological-and innovative type was granted to four cities: Zelenograd, Dubna, Saint Petersburg and Tomsk. The establishment of a special economic zone in Dubna and an innovation belt around JINR will be of great profit to the Institute, its member States, the region and Russia as a whole. The main specializations of the Dubna SEZ are related to nuclear physics and IT technologies. These activities are fully basing on our fundamental results, on our research achievements over the decades.

Russia has as an objective to develop the innovative component of the economy, but, unfortunately, the situation has not fundamentally changed in the Russian economy yet. Systems of education, management and politics, settling and allocation of productive forces even in the most prosperous countries fail to confront the new challenges of today. In these circumstances any developed country may become a leader that within a short period will create an innovation model and replicate it. For our country the task is not to lose this competition. Thus, today, like 60 years ago, it is vital not to lose time using the available opportunities.

In April 2008 a session of the Presidium of the RF State Council presided by RF President Dmitri Medvedev was held in Dubna-JINR. It considered the issues of the development of the innovation system in Russia. The President Medvedev pointed out that the domain of scientific research and development and its efficient commercialization is the basis for a competitive industrial production. Dubna-JINR was chosen not by a chance, as the Joint Institute for Nuclear Research is a scientific organization that builds the basis for technological development and is one of the successful models of the innovation economy in Russia.

In conclusion, I would like to mention, that science, education and innovation are the bedrock of a successful economy, particularly as nations are moving toward knowledge-based economies. The integration of this complex of knowledge plays a fundamental role in shaping the national policy on science-related issues and can be considered a driving force for socio-economic development of any State. At least at JINR, we have not doubt about this.

The Interaction between the National Academy of Sciences, Universities and Business in the Development Process of a Knowledge Based Economy

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Mankind has reached a radically new period of its development – a period of transition from the information society into the society of knowledge. This implies that knowledge and intelligence become an important, if not major, means of politics. That is why universities, being the centers for knowledge and education, become subjects of both domestic and foreign politics. Knowledge in present day conditions becomes the key factor of economic development.

Education is a sphere of activity that has a perspective of becoming highly profitable and having high investment potential in the nearest future. It is only possible on the condition that certain elements of market are introduced into the system of education and the whole system is brought in compliance with the current economic situation.

The main objective of further developments in the sphere of higher education and science is a high level of integration with business. Qualitative change should be based on the following principles: national idea of higher education; education system development in compliance with the laws of market economy and with tendencies of the international education system development.

Education at the National Mining University (Ukraine) approaches the level of demand of high-technology industries. Universities are to change their activities radically due to active revival of science intensive industries and growing interest in training engineering and scientific personnel. Modern innovation demands combine production, science, education and business into an integrated innovative model of the country, industry or company. New knowledge for technological specialities becomes complex, problem-oriented and interdisciplinary. That is why we believe that a Mining University graduate must have integrated knowledge of his/her speciality, market and innovation mechanisms, speak foreign languages and be able to put knowledge into practice. All leading Ukrainian universities now adhere to this principle.

We are convinced that present day development of innovations and personnel training must be in line with the interests of State, business and education. Countries such as Russia, Moldova and Kazakhstan approach this standard by providing government approval to projects for attracting big business industries into education. Being a partner, not a source of charity, business sector makes an order for the system of education. National authorities and representatives of science and education must become partners of business sector and facilitate incorporation of the latter into the sphere of science and education.

Interaction between education and science is a complex process with technical universities traditionally having the leading role. The educational process is thereby interrelated with scientific research providing unity of mastering and transferring knowledge. The main principles of economic knowledge are formed in this way.

It is impossible nowadays to force a student to master complicated knowledge effectively without providing the possibilities of using it in his/her future professional activity. Highly technological economy (economy of knowledge) with its demand for highly qualified specialists can motivate students to get proper education.

The national system of higher education in Ukraine possesses both significant pedagogical potential and internationally recognized scientific schools. Universities cooperate with scientific institutions of the National Academy of Sciences of Ukraine, industry and business. Scientific educational centers, common faculties, departments, research laboratories are organized.

Nowadays world universities are transforming themselves into 'economic corporations' that are closely connected with highly technological industries and knowledge transfer partners. All parts of the university structure classify themselves according to their competitiveness and profitability. These factors are of great importance for innovative development of Ukrainian economy and other countries as well. The Mining University has been following these standards for several years.

In Europe and the USA research universities become major centers of elite higher education. The system of such research universities is expected to be formed in Ukraine as well. The National Mining University makes a close study of this sphere and its principles, builds up an innovative infrastructure and develops cooperation with institutions of the National Academy of Sciences, science intensive industries and business.

The important systematic results recently achieved by the Mining University in all spheres of its activity indicate that the University approaches the standards for research universities.

Such centers as the Center for Innovation technologies and Euro integration, the Center of IT, the Project Engineering Center are created within the University. The Institutes of Electrical Power Engineering for Mining and Metallurgy, the Institute of Economics of Industrial Development, the Institute of Pedagogy of Higher Technical Education and the Institute of Humanitarian Problems were created in collaboration with the Academy of sciences.

Technology transfer is the main process of science commercialization that takes place due to innovative structures. The National Mining University initiated the creation of a Technology Transfer Center and the development of a network of such centers in Ukraine. The Transfer Center acts as an independent innovative structure that combines science, technology, industry, market and has all characteristics of a venture enterprise. Steinbeis Foundation network of transfer centers (Germany) can be taken as an example of a global transfer center network.

Academic scientific production complexes 'Safety', 'Power ', 'Coal', 'Mechanical engineering' and 'Info communications' were created under the agreement between the National Mining University and highly technological enterprises and business in order to put these principles into practice. These complexes are, in fact, modern innovative technological centers of the National Mining University. These centers carry out scientific research in the fields of IT, modern electronics and renewable sources of energy, technologies for machine building, metallurgy and solid fuel power engineering with the assistance of the leading banks and enterprises. They take into consideration market economy principles, specific engineering and scientific personnel training, innovations development in science intensive industries, creation of powerful scientific training laboratories. Such mode of action requires a new way of educational process organization from the university, creativity, serious practical training and knowledge of industrial technologies from the teaching staff. All conditions necessary for practicing these ideas are created by business.

The authorized center of Schneider Electric (France), opened in the National Mining University, is the place where both students of the university (specialization 'Electro mechanics') and specialists of various enterprises get effective training.

The main advantage of such centers is the fact that they are 'self-regulated systems' involving young scientists and creative students. Innovative business created on the university basis can get not only self-supporting but also profitable!

Business cannot be forced to invest into scientific research. Business can only be attracted. That's why it is the job of Government to pursue a strategy of unity and mutually beneficial relations between science, education and business.

The National Mining University develops international cooperation in the key directions of innovative power engineering of sustainable development. Leading university departments take part in foreign innovative investment projects and grant programmes. Virtual scientific training laboratories using modern information technologies are created in partnership with German universities.

The Mining University has become one of the co-founders of the International University of Resources (IUR). Integration of leading mining universities of Europe, USA and Canada should yield a high level of international cooperation and influence on research development and staff training. The University carries out a pilot project of the scientific training center entitled 'Stability of geotechnical systems: phenomena, processes, risks' through a grant from the U.S. Civilian Research & Development Foundation.

Mining University programmes 'We are 30' and 'Gifted youth' are intended to improve the professional level of scientific teaching staff. The programmes involve university scientists who are younger than 30, high school and university students willing to acquire new knowledge and become scientists. The main aim of the programmes is to create favorable conditions for young scientists and students to carry out the foreground scientific research. To achieve this aim we use substantial resources, the results of international cooperation and cooperation with business. The implementation of these programmes helps our young people to become better professionally trained and more motivated to get new knowledge. It also raises the general level of scientific research.

We have all necessary evidence of the fact that universities can be profitable under the relevant legislation. According to the international experience, a self-sufficient university acts as a center of the regional innovation infrastructure. Innovation structures (techno park, scientific park) can consist of enterprises established by the students and teachers. An especially important fact is that the students master the basics of innovative enterprise management along with their field of expertise.

One of the examples of innovative structures, which fully corresponds to the abovementioned principles, is a scientific park. The Dnepropetrovsk Scientific Park Center is based in the National Mining University. This is one of the examples of a new university policy: a highly technological product based on the university research is created and offered on the market.

According to the developed countries' experience in building knowledge economy, there are three main components of this strategy. Investments in education, competitive approach to science funding and institutional support of the innovative sector of economy make up a universal formula of success. By creating relevant institutions and setting certain rules, the State acts as an intermediate party whose task is to reveal the economic potential of the scientific sphere, to make science play an intensive role for economic development.

Scientific research is the basis of research level university. Our university raises the importance of research to provide high quality of higher education, create the conditions for integrating science and education and attract gifted young people into the field of scientific research.

Universities in the present-day society get a radically new role: to form an innovative model of a university with a scientific industrial complex. Along with teaching, universities should influence the state of affairs in local areas and in the country as a whole.

Conclusions

- The new development strategy presented by the EU is both a guideline and a serious challenge for the countries of the former Soviet Union. There are no more possibilities of raw material processing and the use of outdated technologies for developing our country. We have to use the EU experience and step forward to the knowledge economy. Privately owned sectors of the national economy are in extreme need of cooperation with advanced science and education.

- Higher education and science in Ukraine are capable to accept the challenge of the 21st century. Giving priority to the innovative development of science and technology will enable the growth of the Ukrainian economy. The most important element of this policy is the transformation into a knowledge based society, which focuses on modern technologies as well. This would be impossible – in order to develop a favorable innovative environment - without a clear and consistent government policy.

- The key approach to the country's innovative development is integration and cooperation between education, science and highly technological industry.

Economy of Culture in the Information Society Based on Knowledge

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The article develops a vision regarding the convergence between evolutions of cultural institutions, holders of knowledge and artistic values (libraries, archives, museums) and information and communication technologies, in a context created by international initiatives aimed at clarifying concepts and at building an economy of culture as part of a global information society based on knowledge. The paper identifies preliminary actors and key decisions and also presents several possible scenarios, depending on uncontrolled and unpredictable evolutions of some factors from the context.

Keywords: cultural goods, economy of culture, culture institutions, international initiatives, information technologies, knowledge society.

1. Introduction

The goal of this article is to present an up-to-date version of a vision proposed and developed in previous works (Filip, 1996 a, b) regarding the possibility of interaction among different factors (government, culture institutions, population, lucrative organizations, education and research) in order to preserve and valorize for the benefit of country, citizens and economic agents (traditional or new) the national cultural heritage. The basic elements determining the need for extension and for updating previous models result from more systematic and dynamic international approaches and from recent technological developments.

2. International context

2.1. History

Similar to many other domains of human activity in rapid expansion, the first initiatives regarding the use of information technologies within culture institutions depositing cultural goods (knowledge and artistic values) appeared in the *academic world.* Scientists wanted to find new ways of preserving cultural goods accumulated for centuries of human development, as well as to increase the number of people with unlimited (from financial, geographical, social reasons) and rapid access (Dertouzos, 1991, 1997, Saltzer, 1992).

The business world has promptly understood the opportunity to valorize noble initiatives of the scientists into new lucrative activities. The goal of these activities is to valorize, from the economic point of view, cultural heritage from libraries, archives, museums and collections, as well as to efficiently strengthen the connection between the contemporary creator of knowledge and artistic values and the beneficiary and consumer of the production from libraries, exhibition halls and theaters (Dertouzos, 1997; Martin, 1998). In this context, it was said that 'cultural heritage for Europe is a strategic resource playing the same role as petrol for Arabian countries' (De Michelis, 1996). Although such forecasts have not been confirmed yet, in the business world have recently appeared besides technology producers, a series of economic organizations that transform, distribute and intermediate *transformed cultural goods*.

A special attention was paid to libraries and archives, the main institutions depositing information and knowledge. In order to increase labor productivity for various products and services through improved access (speed and area covered), there have been created informational instruments to assists the transformation and functioning similar to that of industrial enterprises or service providers (FN, 2001).

The third factor involved in the interaction between information technologies, creators and cultural institutions was *governmental action*. The governments of developed countries understood that *global information society* (GIS) may have a more important cultural dimension than the industrial society. This dimension was perceived as being good for the citizens ('enriched' spiritually) and for enterprises (that need to interact, not only be opponents, in the economic context which is in the process of globalization) and for communities, States and regions.

The main initiatives with a direct impact in interest area of this study were: a) American programme by NSF/DARPA/NASA entitled 'Research in Digital Library Initiative' (NSF 1998), b) Bangemann Report (1994) addressed to the Council of Europe (with regard to stimulation of the *content industry*) and especially, c) some pilot projects launched at the G7 Conference in Brussels, in February 1995.

(G7, 1995). These referred to: a) 'Intercultural education and training in GIS' (topic nr. 3), b) 'Digitised libraries' (topic nr. 4) and c) 'Extended multimedia access to the world cultural heritage from museums and art galleries' (topic nr. 5). These projects were described during the symposium 'The role of contemporary technology in the development of national cultural heritage', organized by the Romanian Academy on February 21, 1996. During the symposium was also presented the first site containing cultural information developed by ICI Bucharest, a virtual excursion to world museums and libraries. Moreover, it was presented a vision regarding the relationships to be set among various factors (governmental, culture and research institutions, educational institutions and the business world) contributing to the valorization of the national cultural heritage (Filip, 1996; Cristea, 1996; Neamțu, 1996).

2.2. Recent European trends

In Europe, it was officially accepted that 'European cultural resources and scientific knowledge constitute a unique public resource, which forms a collective memory in evolution of various (EU) societies and that constitutes a solid basis for the development of digital content industries in a sustainable knowledge society' (Lund, 2001). It has been estimated (Euroabstracts, 2001) that 'the enormous value of European cultural heritage is approximately twice bigger that the telecommunications sector'. Currently there are talks not only about content industry sector, but about 'the economy of culture'. Starting from this observation, a series of studies and analysis, brainstorming meetings, experts and member States representatives meetings (Lund, 2001; Eva, 2001; DigiCULT 2001; Slazburg Research, 2001; Bride, 2001; FN 1998) have been trying to make a contribution to the outline of a coherent European strategy for the next 5-10 years. The main concrete elements for the actual study are given below:

- Adoption of the Action Plan *eEurope* at the European Council meeting in Feira (June 19-20, 2000). The *3rd* objective of the Action Plan refers to the 'stimulation of European content in global networks' and stipulates the 'creation of a coordination mechanism for digitization programmes between member States'.
- Adoption by the European Council on 22 December 2000 of the *eContent* programme with a budget of 100 million Euro. It aims at 'transforming the rich European [informational] content base into a competitive advantage in an information society and to ensure a more important position on the Internet for European operators' through 'access to and use of information from public sector as well as extending information offer, cultural and linguistic adaptation of information products and removing commercial barriers' (EC 2000b). The action lines of the eContent program are: 'a) improvement of access and extended use of information from public sector, b) extending content production in a multicultural and multilinguistic context and c) increasing the dynamism of the digital content market'.
- Inclusion in the Action programme *eEurope+* (EC 2000a) intended for countries from Central and Eastern Europe of some actions regarding: 'a) stimulation of development and dissemination of European digital 'content' (action 3d), support of information exploitation form public sector and set up of an European digital collection of 'key' databases and b) access to digitized cultural heritage'.
- Digital Library Initiative (DLI) aims at making Europe's diverse cultural and scientific heritage (books, films, maps, photographs, music, etc.) easier and more interesting to use online for work, leisure and/or study. It builds on Europe's rich heritage combining multicultural and multilingual environments with technological advances and new business models. It consists of two strands:

Cultural heritage: to build a common European Digital Library which would serve as a multilingual internet access point to cultural collections from all Member States (Communication from the Commission 'i2010: Digital Libraries', 30 September 2005)[32].

Scientific heritage: to ensure current and future access for research and innovation purposes.

3. Developing a vision regarding SI-SC in Romania with regard to the discussed topic

In a previous work (Filip, 1996a) there was proposed a vision upon the *convergence* of evolution of cultural institutions (libraries, museums, archives) and information technologies, being supported by arguments and emphasizing the limits and potential risks of such an action. In other previous works (Filip, 1996b; Filip, Donciulescu, Sauer, 1996; Filip, Donciulescu, Filip, 2000) this vision has been developed and supported by mathematical models which can be used for effects of various decisions regarding direct investments in cultural institu-

[32] See http://ec.europa.eu/information_society/activities/digital_libraries/doc/communication/en_comm_digital_libraries.pdf

tions, initiation of lucrative activities aimed at valorizing the transformed (digitized) cultural goods, the paid rights of cultural institutions etc. Below will be detailed some of the central up-to-date ideas on the vision and the model presented before.

3.1. Computers in libraries

In an attempt of defining 'year 2000 library', Saltzer (1992) shows some attributes of the library. The fund of physical cultural objects (books, manuscripts, scores, maps etc.) is *selective* (not everything is written, is published and not all publications are collected in libraries), *persistent* (aimed at storage/recording for a long period) and intended for use by a certain audience (unrestricted or belonging to certain categories with various access rights according to the type of library). The tasks of the librarians are not only collection, maintenance and management of the fund of cultural objects, but also assistance to users, this being the main difference between them and simple collectors.

In the case of public libraries, the 'logical collections'(containing information on objects and several catalogues, indexes etc.) outrun 'physical collections' of objects. The partition characteristic of the library, economical reasoning as well as the limited storage space, have led to this situation, whilst the recent development of communications amplified this phenomena. There are States in the USA, where a university library does not purchases a second copy of the magazine if it exits in another university library connected in the network. Recently there is a tendency among libraries to specialize, some concentrating on the accumulation of physical objects while others gather collections of information on objects and provide information and services (Saltzer, 1992).

When analyzing the use of computer in libraries during the last decades, three main characteristics can be mentioned (Saltzer, 1992):

- the first one consists in the automatization of the traditional functions (acquisitions, processing catalogues, management of borrowings and changes);
- the second one consists in the discovery of relevant documents, varying from simple searches, using classical techniques of information search (i.e. indicate all works of author X, existing at the library) to searches with elements of artificial intelligence, having results that at the moment seem less relevant (i.e. search of works containing the idea presented in work Y);
- the third direction of computer use consists in content storage and 'surfing' from text in the quoted references.

Some years ago, Saltzer (1992) proposed a simple and precise vision of the 'year 2000 library', presented below:

- Anybody connected to the network by means of a PC or a workstation (WS) can 'skim through' any book, newspaper, manuscript, score, technical report stored 'on-line' without going to the library;
- When reading over the document, the text of a quoted reference is presented in a window on the screen, the library thus becoming a huge hypertext system. The goal is not to replace books, but to facilitate 'skimming through' books before borrowing them, physical protection and parallel (several readers to the same object) and multiple (one reader to several libraries) access.

Many of the technological problems, that conditioned the implementation of this vision (improving screen resolution of workstations, increasing network transmission speed to millions of characters per second, developing hypertext databases, 'client-server' architectures and increasing the capacity of external magnetic memories) have already been solved to a certain extent.

Leaving from an observation made at the beginning of this chapter regarding specialization of libraries, the vision can be detailed and extended. Therefore, there can be 'purely electronic' libraries (not simply 'digitized'), that are specialized or intended for serving a well delimited geographical area (from the point of view of minimizing data transmission costs). These libraries can gather information about physical objects (as well as 'digitized fund') and can provide on-line documentation services at the library premises or rather distance services based on requests sent in advance (in order to solve problems regarding access priorities and the amount of data necessary to be stored 'on-line'). In the last case, the similitude to modern VOD ('video on demand') systems is not random, but is based on technological achievements in broadband networks field and 'client-server' architectures. These developments are stimulated not only by new modalities of distance work such as 'telework' (Britton, 1994) regarding the 'access' aspect, but also by new ways of cheap and especially rapid production of electronic magazines and volumes, which allow an almost 'real time' distribution of some information (especially scientific) as soon as it appears.

Nowadays, a monochrome book of 400 pages, containing text only, after scan and data compression needs 30 Mb. Therefore on a CD-ROM (650 Mb) can be 'deposited' about 20 books of this kind. From the point of view of the costs everything seems very promising: according to actual prices, an electronic copy of a book on a CD-ROM costs about 40 cents, the space needed being much smaller, whilst supervision and access are obviously much simpler and safer. The time needed for an electronic copy is much shorter that the time for printing (even in modern conditions). It is especially important (in terms of years) when we intend to make electronic copies for entire collections or libraries, even if modern technologies like Photo CD (the price is of tens of thousands) are being used. Talking about the Library of the National Institute for Research and Development in Informatics (ICI), which has stored about 30.000 volumes in the last 30 years, the implementation of the electronic versions would result in over 1500 CD-ROMs. The cost and time of transformation in this case are acceptable. But if talking about the Library of the Academy and about its fund of about 10 million objects (books, newspapers, manuscripts, medals) we intend to digitize only 1,6 million volumes; in other words 80.000 CD-ROMs are needed to host the information that is estimated at 50 Terabytes (10^{11}). It is obviously a complicated and time consuming task. But it should be analysed and eventually performed. Let us not forget that the Library of Congress from Washington comprises 90 million works which represents 2,7 Pentabytes (10^{14})! or 337500 flash-cards of 8 Gb each.

3.2. Transition towards global and virtual culture institutions

Many of the elements describing the digitization process of libraries (premises, approaches, some technological solutions) can be extended for other components of the institutions that host national cultural heritage (museums, historical monuments and sites). Therefore, below there will be presented in general a possible transition from the current modality of valorization of the cultural fund of physical objects and information (including reference info) about this objects gathered within culture institutions (CI). This transition in characterized by several possible convergences.

Convergence will have an *impact on several fields*, like:

a) education (by increasing quality and attractiveness, variety and efficacy);
b) tourism (diversification of services offered);
c) research (by facilitating the access to information;,
d) trade (by increasing the value of the direct and indirect electronic commerce with information);
e) consumer goods industry (appearance of new products);
f) entertainment and audio-visual sector (novelty, diversity and volume increase);
and
g) creators of scientific information and cultural values (by increasing the visibility and appearance of new expression means).

Convergence can be accomplished only through conscious interaction and *network cooperation among several categories of factors*: a) *culture institutions* (CI) (libraries, museums, galleries, archives) holders of *cultural goods* (CG); b) *traditional transformers of cultural goods* (TTCG) (publishing houses, albums, catalogues, movie producers); c) *new transformers of cultural goods* (NTCG) (CD-ROM producers); d) distribution and intermediary organizations for TTCG (bookshops, kiosks, agencies) (DTTCG); e) *service providers* (SP) that explore the *digitized content* (DC), hosted or transferred by CI by means of *network operators* (NO). A special role is played by the *audience,* which is divided in *direct audience* (DA) having direct access (DA) to CG or *extended audience* (EA), that acquires traditionally and newly transformed goods – or virtual audience (VA) that has i*ndirect distance access* (IDA) for charge, to digitized content through service providers.

Taking into account recent tendencies described in article 2.2, the model needs to be complemented by:

a) governmental intervention (represented by state orders regarding access of new generation to cultural heritage and increasing country visibility);
b) explicit consideration of indirect interactions (represented by globalization and location of digital content) with foreign partners (culture institutions, service providers, financial institutions as PHARE, BERD and CE trough specialised programmes);
c) amplifying intervention of the interested economic agents, especially regarding increased access to scientific knowledge from abroad for continuing education of the employees;
d) new possibilities of the knowledge and artistic works creator to interact with the audience by means of service providers.

Of course there are other factors which interfere indirectly facilitating interactions such as banks, intermediary, consulting organizations, or those specialised in new digitization activities.

Further on we will clarify possible problems, in an attempt to answer some of the worries regarding a seeming invasion of technology and economic interests into noble and generous activities of culture institutions.

3.3. Why? (or what) a real library/museum cannot do

In order to directly perceive /have direct access to real objects, the visitor/reader must be 'there' at certain times on certain days when access is permitted, which is hardly possible for an occasional visitor. Culture institutions cannot present everything because of various reasons, whilst the modern person being time-stressed, can hardly find what he's interested in without proper guidance/individual assistance. Researchers have considerable difficulties in carrying out their studies when the subjects (or parts of them) are situated in different widespread places from the geographical point of view (rooms, floor, buildings, cities or even countries).

Because 'teleportation' of human beings anticipated in SF series is not yet possible, virtual teleportation of objects, performed through electronic access from home or study room seems to be an acceptable solution for the moment. Access 'without borders' to cultural values, at any hour for the novices, elderly, isolated people or with disabilities, without sufficient financial resources, etc. can be considered not only an accessible and comfortable surrogate, but is also a means for *democratization, integration and nondiscrimination*. It is also to be expected that distance access will not estrange people from the real culture institution, but will rather stimulate them to visit these institutions. Experience has shown that older or newer means (albums, devices, video tapes, compact discs) with traditionally (transformed) cultural products (TTP) have raised interest to visit culture institutions from a considerable part of the extended audience (EA). It is also to be expected that a considerable part of an almost infinite virtual audience (VA) due to widespread networks, will also be tempted to increase the number of direct visitors (direct audience, DA).

At this moment it is important to highlight an essential attribute of the distance access, which is completely different from traditional means (published works, tapes, CD). Informational content of network 'servers' is dynamic with a possibility of continuous updating and extension, compared to traditional means which are frozen for at least a period of time because any modification means a new publication. Of course, traditional means have their specific role. These are the physical objects themselves that can be made up of collections, thus recording collector's memories about the places they were purchased from or the events associated.

3.4. What cannot be achieved by virtual presence

First of all, the object cannot be touched. Second, it cannot be perceived in its natural environment (library or museum hall, nature). The clouds passing on the sky above a monument or the change of lights in a museum hall due to hour and season, or the street noise heard in the library can be reproduced technically, whilst things like the smell of old books, the excitement of encountering certain objects and the feeling of intimate communication with other users present in front of the same object are impossible to transmit trough computers or networks.

4. Preliminary formulation of some options

For the formulation of preliminary options the *method of scenarios* will be used (Shoemaker, 1995).

4.1 Elements taken into consideration

The main elements participating in the development of scenarios are given below.

Key decision variables, which refer to: a) decisions regarding systematic digitization and connection (of culture institutions) to international projects and networks; b) initiation of investments regarding provision of digital content services (service providers); c) diversity and convergence of methods for transformation of cultural goods (for traditional and new transformers of cultural goods); d) the degree of governmental involvement by means of programmes and state orders and by acceptance of European recommendations (by the government).

Factors influencing decisions are first of all European approaches that are in process of clarification and adoption; secondly, there are technologies under development and their accessibility (from the point of view of costs), development opportunities of informational infrastructures, and the regulations regarding the statute of public culture institutions.

Main uncertainties refer first of all to the economic evolution in general, having an impact on the purchasing power of consumers and the attitude of the public, towards successful Euro-Atlantic integration, that influences the interest of other countries for the current Romanian cultural content.

4.2. Some scenarios

Further on, several scenarios will be presented in brief:

4.2.1. Pessimistic scenario

Economic stagnation; legislation does not allow efficient valorization of the cultural content of public institutions, integration fails; a considerable number of governmental programmes are initiated, but the financing is insufficient; the preferences of the population worsen due to negative impact of TV programmes and other facile productions. In the best of cases only several culture institutions get involved occasionally and without proper support in a limited number of international projects and networks; there are also a few service providers offering important digitized cultural content without proper location.

4.2.2. Optimistic scenario

Economy develops successfully (information technology sector contributes 30% to GDP); Romanian initiatives of EU integration are successful; population has sufficient financial means and is educated in the spirit of real cultural values; infrastructure develops, the government takes into consideration European recommendations and initiatives. In this case, the goal corresponding to the vision presented in chapter 6 is accomplished in 2003 (2004), in every village there are cultural centers and schools with electronic books and with access to the digitized content of the great libraries and museums.

4.2.3. Intermediary scenario (A)

Economy has a slow but continuous ascendant evolution; although integration is delayed, the exterior interest towards Romania increases significantly; young population has a reasonable interest for real culture; employers understand the importance of continuous education; several governmental projects are successful. Under these conditions, the government supports (with information and funds) the involvement of culture institutions and service providers in European projects and initiatives; professional associations of cultural institutions and service providers cooperate reasonably supporting the interests of its members and of the public; research creates instruments for 'localization' of important cultural digitized content.

4.2.4. Intermediary scenario (B)

The same premises from the above scenario are used. The decisions made are used for performance of a directing, fundamental project (by participation of all the representatives of the factors mentioned in article 4.1), that follows European tendencies and recommendations in an Action plan. This project is constantly brought up-to-date and represents a credible reference for governmental bodies and private sector.

5. Conclusions

International evolutions, characterized first of all by multiplication of initiatives, deepening of the systematic character of approaches by governmental factors as well as ambitious goals and rapid developments have determined the need to update the previous vision. The main conclusions are as follows:

- Access improvement as well as national and international valorization of the national cultural heritage have already become the subject of several national recommendations. These tasks have to be supplemented with dual elements of location and access facilitation to international cultural goods (knowledge and artistic values) in a global knowledge society that aims to respect and cultivate multilinguism and the contribution of every country to the diversity of collective culture memory. In this context, it is important to take into account the danger of unbalanced import-export ratio of cultural content in favor of import of foreign digitized content, either 'located' or not.
- The achievement of the desired goals: not only an increase of labor productivity (accent on knowledge related elements), but also 'enrich' citizens – without interaction and loyal cooperation of different groups of factors (governmental, culture institutions, academic world, lucrative organizations, creators of knowledge and artistic values) in a balanced way and using significant funds, from public and private sources.
- The directions of this movement are based on detailed studies carried out internationally form multiple perspectives by research institutions and consortia, involving impressive intellectual potential.
- With regard to internal evolutions in this field, it is important to understand that they can be analyzed only in the context of general evolution of the country (economy and population preferences) and that they also depend on the international perception and interest towards Romania, which are still influenced by many uncertainties.
- Highly important is to closely follow international tendencies, desirably in a systematic manner and with organizational and financial support from the State, paying special attention to various initiatives and movements that aim at the creation of a global economy of culture.

References

- Bangemann, M. (1994) *Europe and Global Information Society*. *Report to European Council*, 24-25 June, (translated into Romanian in the *Romanian Magazine of Informatics and Automatics* (PRIA), 4(2-3), P.2-26).
- Bide, M. (2001) *Business Models for Distribution Archiving and Use of Electronic Information: Towards a Value Chain Perspective*, Mark Bide &Associates.
- CELIP (2001a) *Accesul la resursele electronice. Aspecte privind licențele în biblioteci* (http://www.eblida.org/celip/workshops/romania_agenda.html) (in Romanian).
- CELIP (2001b) *Licensing issues for Central and Eastern Europe* (http://www.eblida.org/celip/workshops).
- Cristea M. (1996) 'S-ar putea face mai mult în privința popularizării patrimoniului național' in *Computer World Romania*, April, p. 9.
- CULTIVATE (2001) (http://www.cultivate-eu.org).
- De Michelis (1996) 'VENIVA ESPRIT Project and the cultural heritage as a natural resource in the 21st Century', in *Proc. EVA'96*, Cappelini V. and Hemsley J. (Eds.), Florence.
- Dertouzos, M. (1991) 'Building the Information Marketplace', in *Technology Reviews*, 94 (1), p. 29-40.
- Dertouzos, M. (1997) *What It Will Be*, Harper Edge, New York.
- Digicult (2001) *Key Background Information and the Cultural Heritage* (http://www.cordis.eu/ist/ka3/digicult/en/bactgrd.html).
- DigiCULT (2001) *Digital Heritage and Cultural Content* (http://www.cordis.eu/ist/ka3/digicult.htm).
- EAN (2001) The European Archival Network (http://www.european-archival.net).
- EC (European Commission) (2001) *Cultural Heritage in FP6* (http://www.cordis.eu/ist/ka3/digicult/en/fp6.html).
- EC (European Commission) 2000 a) *eEurope+ for Candidate Countries* (http://europa.eu.int/information_societz/eeuropa/index_enhtm).
- EC (European Commission) 2000 b) *eContent*, Press Release/22.17.00.
- EC DGXIII/E-4 (1991) *Report on the Situation of Libraries, Museums and Archives in the EU Member States and EFTA Countries* (http://www.eu/libraries/en/nfp/introd.html).
- eContent (2001) *European Content on Digital Networks* (http://www.cordis.eu/econtent).
- eCulture (2001) *A Newsletter on Cultural Content and Digital Heritage* (http://www.cordis.lu/ist/ka3/digicult/en/newsletter.html).
- EVA (2001*) The Florence Agenda: Trends and Future Developments in ICT for Culture and Science* (http://www.cordis.eu/ist/ka3/digicult/en/florena-agenda.html).
- F.N. (2001) 'Library Management Systems', in *Managing information*, 8 (3), April, p. 32.
- Filip, F.G. (1995) 'Tehnologiile Informatice pentru Procesele Lucrative', in *Academica*, An V, 6 (154), p. 20-21 (in Romanian).
- Filip, F.G. (1996) 'Information Technologies in Cultural Institutions' in *Studies in Informatics and Control*, *sic,* 6(14), p. 385-400.
- Filip, F.G., D. Donciulescu, F. G. Filip (2000) 'A Cybernetic Model of Computerization of the Cultural Heritage', in *Proceedings of the 8th IEEE Mediterranean Conference on Control & Automation - MED 2000, Patras*, July 17-19 (CD-ROM).

- Filip, F.G., D. Donciulescu, Carmen Sauer (1996). Towards cultural integration of Romania by using information technology. In *Proceedings Electronic and Virtual Arts-EVA'96*, Paris, Vol. 4, p. 45-50.
- Filip, F.G. (1996) 'Tehnologiile informaţionale şi valorificarea patrimoniului cultural naţional' in *Academica*, An VI, 9 (69), p. 22-24 (in Romanian).
- FN (1998) 'Convergence in the Digital Age: Challenges for Libraries, Museums and Archives', in *Proceedings of the Seminar*, held in Amsterdam, 13-14 August.
- G7 (1995) *Information Society Conference. Pilot Projects, Executive Summary*, Brussels, 25-27 February.
- Lund (2001)*The Lund Principles. Conclusions of Expert Meeting*, Lund, 4 April 2001 (http://cordis.eu/ist/ka3/digicult/en/eeurope.html).
- Martin, C. (1998) 'The time dynamics of future publishing', in *Blueprint to the Digital Economy. Creating Wealth in the Era of e-Business*, D. Tapscott (Ed.), Mc.Graw Hill, New York.
- Matei, D. (1996) *Crearea infrastructurii informaţiei a instituţiilor culturale din România*, CIMEC Bucharest (in Romanian).
- Neamţu, L. (1996) 'Punct de plecare: cabinetul de manuscrise rare al Bibliotecii Academiei. Punct de sosire: plasarea României pe orbita Internet', in *Totuşi iubirea*, VIII, Nr. 26/27, p. 24-25.
- NSF (1998) *Digital Libraries Initiative. Phase2* (http://www.nsf.gov/pubs/1998/nsf9863/nsf9863.htm).
- Saltzer, J.H. (1992) 'Technology networks and the library of the Year 2000', in *Future Tendencies in Computer Science, Control and Applied Mathematics*, Bensoussan, A. and Verjus J.P. (Eds.), Springer Verlag, Berlin, p. 51-67.
- Salzburg Research (2001) *Europe's Memory Institutions on Their Way into the Digital Cultural Economy*, DigiCULT Study (http://www.salzburgresearchat/fbi/digicult/start.html).
- Shoemaker, P.J.H. (1995) 'Scenario planning: a tool for strategic thinking', in MIT *Sloan* Management Review, 36(2), p. 25-40.
- TEL (2001) The European Library (http://www.europeanlibrary.org).
- TfL(1998) Telematics for Libraries (http://www.cordis.eu/libraries/en/libraries.html).

CHAPTER IV

Stemming and Reversing Brain Drain

Stemming and Reversing Brain Drain: a Global Perspective

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International migration can have both positive and negative effects for both countries of origin and destination. International migration often results in the outflow of individuals who are highly skilled and have attained higher levels of education, known as 'brain drain' which has potential negative effects on countries of origin.

On the other hand, an expatriate skilled population abroad is a potential asset for the sending country provided that the skills of migrants are well utilized and further developed, there is a network or mechanism for transferring skills and knowledge and the home country is able to make good use of these contributions. However, where emigration is long-term and/or permanent, the country of origin may lose its original investment in the education and training of the migrant, and its future development potential may be hindered by this loss. 'Brain drain' is especially significant in the poorest countries where the pool of skilled people may already be small due to limited educational infrastructure and funding, and for the same reasons difficult to replace. Skill shortages in such critical sectors as health care and education are of particular concern.

Defining the highly skilled

A clear definition does not exist which captures all aspects of highly skilled migration. Indicators may include a combination of education level and occupation or professional activity and experience. Depending on the final purpose, different indicators may be considered. For policy purposes, this is often a mix between education and occupation. The basic definition identifies the highly skilled as persons with a tertiary education, i.e. generally two or more years of college education, and is the most readily available international statistic. Therefore, existing data on the mobility of the highly skilled is limited to an assessment of the tertiary educated[33]. In the case of developing countries, they are often reliant on the statistics of destination countries.

Trends in highly skilled migration

Two significant trends in highly skilled migration have been noted in recent years: 1) temporary highly skilled workers and 2) students. For the purposes of this conference paper, the primary focus will be on students. According to the OECD 650,000 temporary highly skilled workers are admitted yearly to OECD countries, three times as many since the 1990s (2006a). In addition, higher education has become increasingly international since 1990.

[33] See also OECD, 2006 and IOM, *World Migration Report,* 2008.

There has been an increase in the international mobility of students and professors as well as in the number of international educational programmes and higher education institutions. OECD countries have also seen a rise in foreign students from 800,000 in 1980 to 1.2 million in 1990 to 2.7 million in 2004 (OECD, 2006b). The rise in student migration is likely to influence the future volume, composition and destination of highly skilled migration.

In the US an increase to 30 percent from 25 percent of admissions of highly skilled migrants occurred in the early 1990s, most likely due to increases in visas for temporary and permanent highly skilled workers, and then stabilized by the mid-1990s (Lowell, 2008). On the other hand, the growth of highly skilled migration to European Union (EU) countries started later in the1990s, stabilizing around 2000 at the height of the ICT boom, suggesting that economic conditions influence trends, despite policies to attract the highly skilled (Lowell, 2008).

In general, the majority of highly skilled migrants come from developing countries with Asian born migrants compromising the largest internationally mobile population, 35 percent of the world total according to the OECD. The breakdown from other regions is as follows: Europeans 34 percent of the highly educated abroad (mainly EU 25); Latin America and the Caribbean 23 percent of the total; Africa 7 percent of the total. A large share of these highly skilled movements occurs within a given region. For example, intra-European student migration accounts for 81 percent (OECD, 2004) and in countries such as Japan and South Korea, the largest share of highly skilled migrants come from other Asian countries (Docquier and Marfouk, 2006).

The rapid internationalization of higher education and the effort made by universities and States in furthering international student mobility, has important implications for both education and migration systems around the world especially at a time when more and more industrialized countries are looking for ways to facilitate the migration of the highly skilled to help boost their economies (Vincent-Lancrin, 2008). This dynamic has given rise to a new debate on 'brain drain' as the effects of student migration on sending countries are often seen as mixed. On the one hand there is a concern about the loss of human capital in developing countries, though it is important to note that brain drain is not restricted to developing countries alone - the issue is also prominent in migration debates in European countries and the US. On the other hand, sending countries can benefit from highly skilled nationals educated abroad, either upon their return or if they remain abroad, such as through remittances and skills transfers.

OECD countries host 85 percent of the total number of foreign students in the world. Out of the top 10 receiving countries, hosting 75 percent of the foreign students, only the Russian Federation and South Africa are not OECD member states. The five OECD English speaking countries (USA, UK, Australia, Canada and New Zealand) received almost half (47%) of the total number of foreign students enrolled in the world. Developing countries are usually those with the highest amount of foreign students as a percentage of the total number of students enrolled in tertiary education. The main reason for this is that usually that countries offer a limited number of disciplines and opportunities and therefore a limited size of their tertiary education system. However, this may be true for certain developing countries. Luxemburg, for example, had two times more tertiary students abroad than enrolled in national universities in 2004 (UNESCO cited in Vincent-Lancrin, 2008).

Gendered Dimension of Brain Drain

Though highly educated women make a distinct contribution to the social and economic development of developing countries, the gender dimension of the international mobility of the highly skilled has been almost entirely neglected. Research has shown that the education level of mothers has a positive effect on the human capital accumulation of their children (i.e., in education and health). Studies also show that at higher levels of education there is a higher negative impact on countries of origin from brain drain of women than men due to the potential offset at lower education levels attributable to the impact of remittances (Dumont *et al*, 2007). The effect of gender is specifically associated with education levels, so that women with primary educational attainment do not have a significantly different probability to migrate than men. However this is not true for those with secondary and tertiary education levels. This is especially true in poorer regions of the world and raises concern about the impact of female brain drain on the world's poorest countries (Dumont *et al*, 2007).

Drivers of highly skilled migration

Several factors have influenced the numbers and composition of highly skilled migration. Advances in communication and transport have increased awareness of opportunities abroad and facilitated the mobility of the highly skilled in the global economy. In addition, admissions policies are increasingly targeting and attracting the highly skilled (both students and workers), such as through new points-based systems in the UK and already established ones in Australia and Canada. Over the last few years more and more countries have introduced measures that encourage foreign students to stay and work and eventually settle in their host country.

Foreign graduates having already lived for a while in the host country and accustomed to its social and cultural characteristics have become an increasingly important target of policies aimed at attracting and retaining talented human capital. Providing an option to stay after graduation is already a long-standing practice in the USA. In Canada for example, students have the possibility to apply for a post-graduation work permit, which allows them to work in certain jobs for up to two years without approval from the Employment Office. In recent years, European and other countries, like the UK, Germany, France, Austria and New Zealand have started to offer possibilities for post-graduation employment settlement. These possibilities are often tied to already existing or newly introduced labor migration schemes for highly skilled migrants, which grant permanent residence rights to highly skilled migrants either directly of after a certain amount of time. Such policies are driven for a variety of reasons such as the desire to generate additional income or increase the prestige and profile of universities and institutions via high quality personnel, the need for a better educated workforce in emerging sectors and economies and so on (Vincent-Lancrin, 2008).

Other drivers of highly skilled migration include those drivers which are relevant for migration more generally. Persistent wage disparities continue to be a push factor for migration. For new migrants, real income gains - cost-of-living adjusted – rise by nearly 200%* (World Bank, 2006). Furthermore, demographic projections - aging and shrinking populations in industrialized world and growing populations in developing countries are part of the push/pull factors. In high-income countries, the labour force is expected to peak to near 500 million in 2010, and then fall to around 475 million by 2025 (World Bank 2006). Developing countries are forecast to add nearly one billion workers to the world's labor force by 2025 (World Bank 2006). The largest rise in the dependency ratio is expected to be in Europe. For example, taking into consideration the number of elderly per worker, every 100 European workers now support 36 elderly people; by 2025 they will have to support 52 (World Bank 2006).

Policy Issues and Options for Sending and Receiving Countries

In order to alleviate the potential negative effect of brain drain, countries are increasingly considering retention strategies as well as building temporary and circular migration programmes to promote 'brain circulation'. However, measuring the impact of temporary and circular migration, whether negative or positive on a specific country, is complex. The benefits of such policies and programmes are enhanced when migrants are able to maintain strong links with their countries of origin. Policies in both countries of origin and destination which support intellectual/scientific diaspora networks, cooperative projects between expatriates and home country and expanding virtual and distant learning opportunities all facilitate 'brain circulation'. Lowell refers to the types of policies responses as the 6 Rs: return, restriction, recruitment, reparation, resourcing and retention (2002); some of which are described in more detail below.

The return of migrants can contribute to reducing the negative impacts of human capital outflow for countries of origin. They can benefit from return migration in two ways: by regaining the human capital of migrants and by taking advantage of the additional skills and resources returning migrants may have acquired while abroad. However, the extent to which return migration can bring additional benefits by replacing human capital loss with the circulation of human capital is an important question to be explored. Temporary or circular migration schemes to promote 'brain circulation' are one policy option.

Programmes such as IOM's Migration for Development in Africa (MIDA) encourage qualified migrants to return to their countries of origin on a voluntary basis – either temporarily, permanently or virtually – to transfer knowledge, skills and technology in needed sectors such as agriculture, education, health and finance, thereby tapping into the important resources available in the diaspora. However, most efforts by destination countries to encourage the diaspora to contribute to development have focused on remittances and creating diaspora networks to facilitate forms of human capital exchange and, to a lesser extent on ensuring that migrants are employed in sectors and occupations that allow them to accumulate social and financial capital. In addition, flexible residency rights and dual citizenship may help to alleviate the concerns that exist about the ability to return to one's previous occupation and to maintain residency status in the host country.

Furthermore, supporting training/exchange schemes between countries and 'twinning' universities can facilitate the outward mobility of teachers and academic staff through partnerships with local providers. While more and more destination countries are offering work and settlement options to foreign students, as mentioned previously, many countries also have increased the number of scholarships to students from developing countries where the underlying condition for the scholarship holder is to either return to the home country or to pay back the scholarship if the student decides to stay or to move on to a third country. Retention policies can only be successful when combined with reforms in educational sector policies and economic development.

IOM experience and lessons learned

In working with Governments worldwide, IOM has the opportunity to observe effective practices and develop innovative approaches with Governments seeking to make migration work for development:

- Combination of measures are needed – uni-dimensional measures are inadequate;
- Channel migration into regular and humane avenues – including by increasing legal opportunities for labour migration;
- Migrants with secure status in host countries accumulate more skills and resources and contribute more to their home countries;
- Migrants want to help their home countries – a key resource to tap;
- Put in place policies to encourage permanent or temporary return home – promote 'brain gain';
- Engage the private sector in incentive-based approaches to human resource development to meet home and host country needs.

Bibliography

- Docquier, F. and Marfouk. A. (2006), 'International Migration by Educational Attainment (1990-2000)' in Özden C. and Schiff, M.W. (Eds.), *International Migration, Remittances and the Brain Drain*, Palgrave-Macmillan, London, p. 151-200.
- Dumont, J.C., Martin, J.P. and Spielvogel, G. (2007) *Women on the Move: the Neglected Dimension of the Brain Drain,* Institute for the Study of Labour (IZA), Discussion Paper Series, IZA, Bonn.
- Lowell, B. L. (2002) *Policy Responses to the International Mobility of Skilled Labour,* ILO International Migration Papers, nr. 45, ILO, Geneva.
- IOM (2008) 'Highly Skilled Migration' in *World Migration Report*, IOM, Geneva.
- OECD (2004) *Trends in International Migration. Annual Report*, SOPEMI, OECD, Paris.
- OECD (2006a) *International Migration Outlook*, SOPEMI, OECD, Paris.
- OECD (2006b) *Education at a Glance 2006*, www.oecd.org/dataoecd/46/0/37368660.xls.
- UNESCO Institute for Statistics (2006) *Global Education Digest 2006. Comparing Education Statistics Across the World,* Montreal.
- Vincent-Lancrin, S. (2008), 'Student Mobility, Internationalization of Higher Education and Skilled Migration', in *World Migration Report*, IOM, Geneva.
- World Bank (2006) *Global Economic Prospects, Economic Implications of Remittances and Migration,* The International Bank for Reconstruction and Development/The World Bank, Washington DC.

Common Trends of Brain Drain and Brain Circulation within the South Eastern European Region

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Mobility in general has been a constant and influential feature of human history. It has supported the process of global economic growth, contributed to the evolution of States and societies, and enriched many cultures and civilizations. Beyond doubt brain drain continues to be one of the challenges for our contemporary societies marked by multifaceted association between the processes of globalization and highly skilled migration especially for our region in the last decade.

Having in mind two groups of major challenges, namely new paradigms (including complex technologies, global economy, scarce resources, environmental sustainability, demographic shifts, career long learning) and coherent elements of 'knowledge society' (including information explosion, cognitive revolution, diverse labour force, creative transformations, ongoing innovations, infrastructure renewal) SEE countries have to discuss possible policies aimed at developing and preserving our intellectual R&D potential and gaining benefit from 'brain exchange' in a globalized world.

Among other actions, the following measures in particular are very likely to improve the overall situation:

- invest in higher education and research focusing on substantial and long-term actions;
- enhance the promotion of scientific activities;
- invest in highly skilled, 'brilliant' young people;
- make closer science and business;
- closely cooperate at the regional and national level.

The main goal can be defined as follows: in order to become more internationalized and dynamic a research system should be able to translate the research results into relevant and usable knowledge by the economic system and by society at large. Yet emphasis should be put on building the appropriate strategies and schemes for stimulating the return and circulation flow of the young scientists generation leading to new career opportunities in the context of both professional and institutional development.

Problems of Outflow of Young Scientists and Specialists Abroad: the Case of Ukraine

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1. Previously closed to the outside world, Ukraine now gained its firm position in the world (first of all European) migration space. Today, Ukraine is a workforce donor with estimated foreign migration at the level of 2-3 million people, a transit area for countless illegal migrants striving to reach the developed West, and also a refuge for several thousands of refugees from other countries.

In the conditions of openness towards the outside world and deepening of globalization processes, international migration, including migration of skilled workers and intellectuals, has the growing effect on demographic and socioeconomic development of the country and formation of its labor resources [Table 1].

Migration among scientists grew substantially at the beginning of the 1990s [Table 2]. Mainly, their number included specialists in the field of natural sciences, physics, and mathematics, and also biologists, geneticists, and doctors. One-third of all Doctors of Sciences emigrated to Russia, the same number moved to the United States, and other 15% to Israel. Similar was the geography of emigration of candidates to sciences.

The problem was that reformation of the research & development (R&D) system as well as design & experimental sphere coincided in time with the development of a large-scale economic crisis. Moreover, the situation in scientific domain worsened at the much higher rate than general economic decline. Under these conditions, a number of people engaged in scientific research decreased sharply. This happened primarily due to the transition of scientists to other spheres of employment, more attractive in terms of labor remuneration [see Tables 3, 4].

The loss of scientific potential was also caused by the fact that research scientists, nominally working as part of Ukrainian scientific teams, worked for foreign employers. Representative of the Verkhovna Rada of Ukraine for Human Rights estimates that up to 30% of scientists are working on foreign orders today.

2. At the same time, emigration remains an important factor contributing to the decline of Ukrainian educational and scientific potential.

Ukraine has several advantages, first of all quality education; among the disadvantages, besides inflation and excessive tax burden, the most important is 'brain drain'. In this respect, Ukraine was ranked 93rd in the world in 2007. Intellectual emigration substantially reduced our country's competitiveness and worsens the prospects of its development.

Unfortunately, most of the problems of the present state of science in Ukraine became systemic. Protracted social and economic crisis at the beginning of the 1990s resulted in degradation of multilevel system of training scientific brainpower, sharp deterioration of standards of life of scientists, and substantial disproportion in scientist age and qualification balance because of the mass transition of scientists to other spheres of activity and their emigration [Tables 5,6].

On the one hand, above mentioned destructive consequences led to the ageing of the country's scientific manpower potential and the threat of losing famous scientific schools. On the other hand, it has also resulted in the substantial growth of money transfers to countries with the outflow of labor and intellectual migrants [Tables 7, 8, 9].

3. The modern world has already realized that the future of mankind is based on knowledge. As a consequence, strengthening the country's scientific manpower potential and the modern organization of scientific research becomes especially important.

In recent years, despite continuous lack of sufficient funds, the Ukrainian government has nevertheless managed to implement various measures aimed at bringing talented young students in the scientific field and stabilizing the staff of, first of all, academic institutions:

- young scientists may now receive awards, scholarships and grants from the President of Ukraine and the Cabinet of Ministers of Ukraine; several regional forms of support are now developing as well;
- postgraduate scholarships have been increased;
- a favorable pension law for scientists has been approved;
- postgraduate scientific schools can now enroll students all throughout the year;
- new fields of specialization were opened in institutes and universities, prospective faculties and educational sub-faculties were created in academic institutions at the initiative of the National Academy of Sciences of Ukraine;
- massive training of students of institutions of higher education at scientific laboratories and departments of academic institutions was organized, etc.

4. Activities of many international governmental and non-government organizations in Ukraine are also aimed at consolidating and expanding scientific career opportunities for young scientists; increased potential of Ukrainian science is thus due to the involvement of scientific youth in participation in special international programmes and grants.

5. Despite the steady growth of earnings of scientists in recent years, this index still remains substantially lower than in the financial sector, the transport and communication sphere, or in the State administration. Therefore, as a study on labor migration reveals, low workforce price which does not allow to solve vital financial problems became the main reason for emigration [Table 4]. This is especially important for young specialists and skilled workers who do not receive proper remuneration of their work.

Dissatisfaction with opportunities of realizing their creative potential is also very important for intellectuals. According to data provided by the National Academy of Sciences of Ukraine, up to 85% of the science budget is allocated for payment of salaries, bonuses, medical services, etc. In other words, scientific research sphere *per se* receives virtually nothing. Many years of under-funding became the reason for extremely unsatisfactory state of technical and informational support of scientific activities.

6. Government strategy of preventing outflow of scientific workforce abroad must be based on both measures of providing social support to scientists (by creating proper conditions for their life and scientific work) and anti-migration policy measures [Tables 10, 11].

In my opinion this strategy must rest on the principle of ensuring human rights and achieving decent labor standards for the economically active part of population, minimizing migration-caused losses, introducing regulations in the process of Ukraine's integration into the world market, and encouraging Ukraine's integration into the EU.

7. The creation of conditions for bringing young scientists back to Ukraine must be based on the analysis of factors which contribute to the return migration, such as high salaries, existence of high-quality professional environment, rapid professional career growth opportunities, possibility of international professional contacts and travels abroad, access to modern equipment, information and communication tools, independence, non-fixed work schedule, long-term and stable employment, possibility of finding job in a specific city, possibility of solving housing problem.

In this regard, one of today's main priorities is to take appropriate measures aimed at optimizing the structure of the national scientific system in terms of age and professional parameters, realization of potential of creative youth considering differences in motivational mechanisms among young and experienced scientists, while at the same time preserving scientific traditions accumulated during many years and ensuring heredity in development of knowledge and increase of prestige of scientific work, etc.

8. Constant attention should also be paid to the development of scientific activities in Ukrainian regions, in particular, further development of the State network for selection, training, and involvement into the scientific and educational sphere of talented and promising youth according to nowadays conditions and requirements, and training of the scientific workforce from high school, students to young candidates in sciences studies.

The youth as a special socio-demographic group had always required heightened attention from the State. This is why we need to develop thoroughly weighted, systemic, and long-term areas of State policy concerning support offered to scientific youth which, if implemented, may bring positive results in this sphere in the foreseeable future.

Tables

Table 1. Migration in the CIS countries, 2000-2006 (%)

	Immigration			Emigration		
	CIS	Other countries	Total	CIS	Other countries	Total
Armenia	68,1	31,9	100	78,5	21,5	100
Azerbaijan	97,3	2,7	100	96,7	3,3	100
Belarus	88,6	11,4	100	62,3	37,7	100
Georgia	88,4	11,6	100			
Kazakhstan	90,3	9,7	100	73,1	26,9	100
Kyrgyzstan	98,3	1,7	100	92,6	7,4	100
Moldova	52,2	47,8	100	70,4	29,6	100
Russian Federation	95,0	5,0	100	52,2	47,8	100
Tajikistan	99,3	0,7	100	99,6	0,4	100
Ukraine	85,1	14,9	100	61,2	38,8	100
Uzbekistan	97,3	2,7	100	90,3	9,7	100
Total	92,1	7,9	100	71,2	27,8	100

Table 2. Emigration of Ukrainian scientists abroad: departure on a constant residence

Doctors of science	Candidates of science (PhD)
1991 - 39	In the early nineties Ukrainian
1992 - 57	science lost one-sixths part of scientists
1993 - 68	2000 - 125
1994 - 90	2005 - 45
2000 - 26	2006 - 37
2005 - 8	2007 - 10
2006 - 6	
2007 - 1	

Annex 3. Temporary departure for work or training

- In 1992 – 2001, according to official data, 3544 scientists including 778 Doctors of science and 2226 Candidates of science (PhD) left various institutions of National Academy of Sciences of Ukraine for a temporary job.
- Today up to 30 % of the Ukrainian scientists work abroad

Table 4. The reasons of emigration from Ukraine for high-skilled intellectuals

Hope of high earnings	73 %
Desire to run from poverty	46 %
Aspiration to better fulfill personal aptitudes	46 %
Hope to earn money for the family (children)	45 %
Aspiration for a comfortable life in a stable society	44%
Unfeasibility to find a job according to the subject majored in	23%
Intense political situation in the home country	10 %
Unfeasibility to solve a housing problem	7%

Table 5. Emigration bias among intellectuals

I shall not go anywhere, because it couldn't be better than in Ukraine	32,0 %
I would like to leave, but I can't because of personal reasons	22,5 %
I would like to leave, but I am afraid that I won't be able to secure my living abroad	19,5 %
Haven't decided yet whether to leave or not	16,5 %
I plan to leave temporarily to improve my financial situation	6,5 %
Have definitely decided to emigrate to the West	2,5 %
Have decided to leave to a CIS country	0,5 %

Table 6. Consequences of the intellectual migration

• Deterioration of the qualitative characteristics of manpower
• Destruction of the intellectual environment and ageing of the scientific potential of a country
• Losses in: - the education system; - the mental potential reproduction.
• Threat of destruction of scientific schools
• Economic losses of the expenses for training of experts and young scientists (annually about 1 bln. of US dollars)
• Hampering the technical modernization rate
• Deterioration of the educational level of young generations
• In the nineties Ukraine lost 15-20 % of its intellectual potential

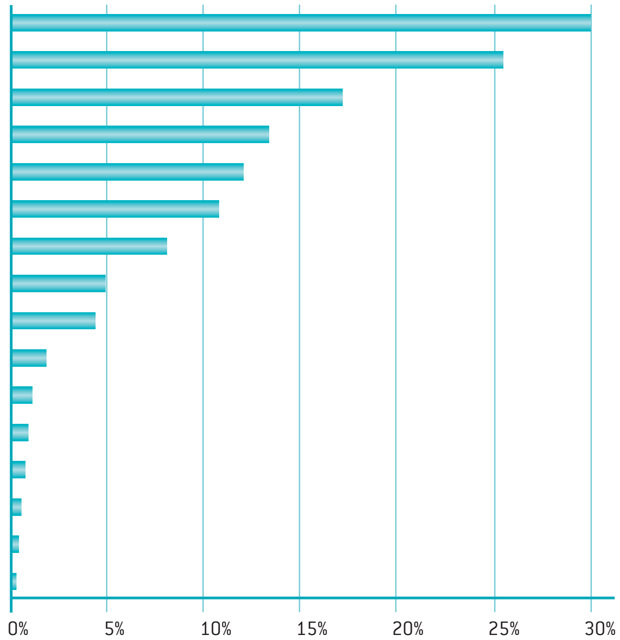
Table 7. Remittances to CIS countries, 2006 (Million USD)

	From	To	% GDP
Armenia	155	1175	18,3
Azerbaijan	300	812	4
Belarus	93	334	0,9
Georgia	24	485	6,4
Kazakhstan	188	3037	0,2
Kyrgyzstan	145	739	27,4
Moldova	85	1182	36,2
Russia	11438	3091	0,3
Tajikistan	30	829	0,8
Ukraine			
Uzbekistan	395	1019	36,2

Source: World Bank Migration and Remittances Factbook 2008

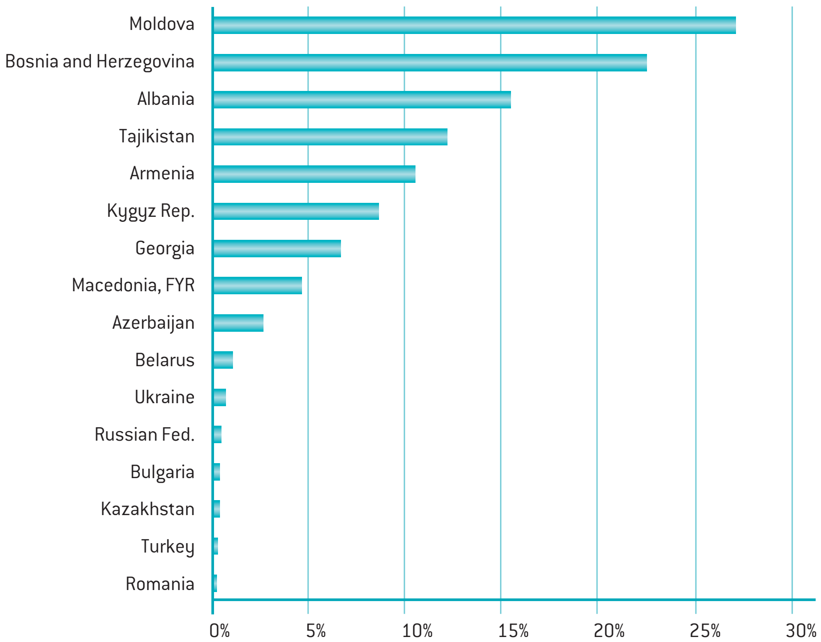
Table 8. THE ROLE OF REMITTANCES

Remittamces as Share of Total Household Expenditure in 2004



Source: IMF, Balance of Payments Statistics, World Economic Outlook; World Bank

Remittamces as a Portion of GDP in Eastern Europe and the Former Soviet Union, 2004



Source: IMF, Balance of Payments Statistics

Table 9. THE ROLE OF REMITTANCES

Earnings of migrants transferred to their home countries, 2001-2005 (% of GDP)

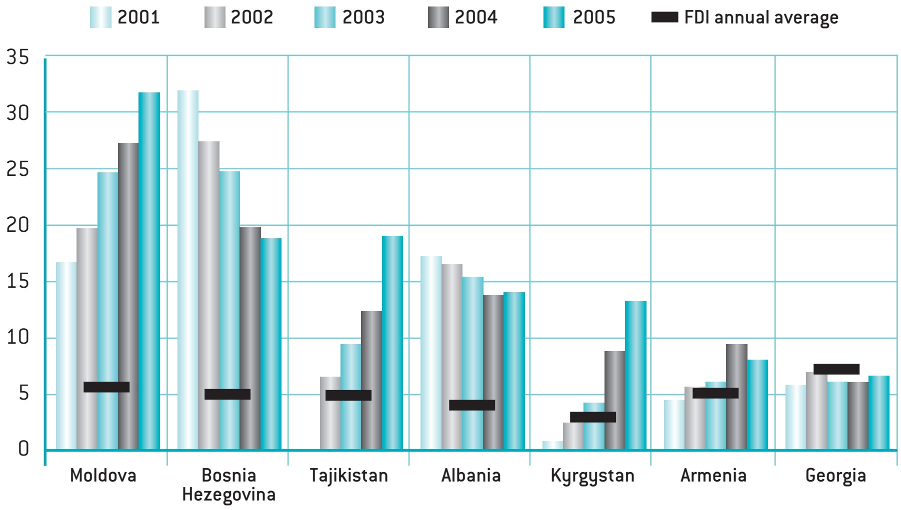


Table 10. Can 'brain drain' be advantageous?

• Mission: to preserve scientific personnel and to secure its qualitative preparation
• Measures:
1. Increasing expenses on science at the level not less than 2% of GDP
2. Improving management efficiency of science, reforming its outmoded model
3. Converting 'brain drain' into 'the turn of brains' which is favorable to a country and to national science
4. Organization of scientific and technical diaspora, stimulus for returning
5. Creation of joint funds for scientific researches, which are of interest for foreign partners

Table 11. Counteraction strategy of the outflow of scientific personnel

• Securing human rights
• Achieving standards of descent work:
- High salary
- Creation of highly professional environment
- Opportunity of rapid career growth
- Opportunity of establishment of international work contacts
- Access to modern equipment
- Opportunity to solve housing problem

Stemming and Reversing Brain Drain: a Role for STCU

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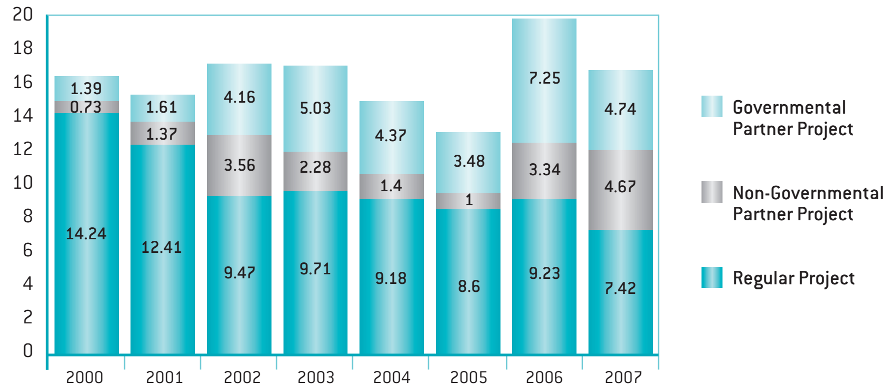
Following the dissolution of the former Soviet Union, the subsequent economic conditions in the newly independent States often made careers in research unattractive. This increased the probability that highly skilled scientists might immigrate to other countries (external brain drain). In some instances, the scientists remained at home, but directed their expertise to less prestigious but often better paying jobs (internal brain drain), other scientists remained unemployed. The existing plight posed a threat to the international non-proliferation efforts. This situation led to the establishment of the Science and Technology Centre in Ukraine (STCU) - an intergovernmental organization dedicated to the prevention of the proliferation of expertise related to weapons of mass destruction (WMD).

For more than 12 years, STCU has been working at redirecting the former Soviet scientists from Azerbaijan, Georgia, Moldavia, Ukraine and Uzbekistan that were engaged in the development of weapons of mass destruction (WMD). In such an approach, the former weapon scientists (FWS) remained 'at home' whilst channelling their expertise into peaceful, productive and sustainable civilian research activities. Research projects can either be funded as Regular or as Partner Projects. The former are initiated by the Recipient technical units/institutions and financed by one or more of the Western Funding Parties (Canada, the European Union and the USA).

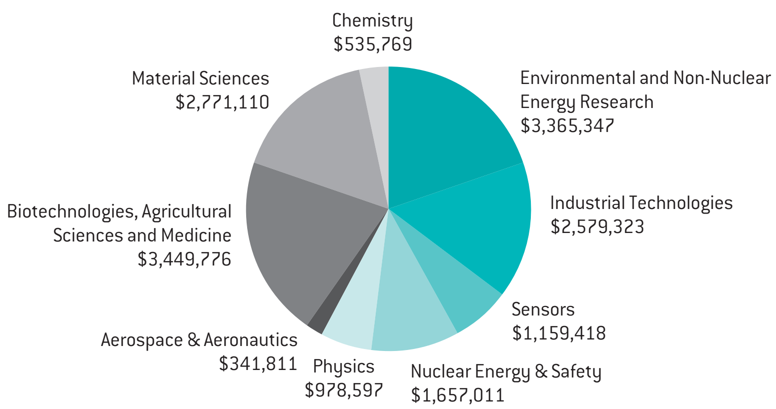
In contrast, Partner Projects are often initiated by governmental organization or non-governmental organization within the Donor States. Western scientific collaborators are an important part of the process and are effectively used to increase the level of interaction between FWS and scientists in the Donor States. As such, STCU project activity seeks to facilitate the integration of the FWS into the international civilian S&T community.

In recent years, STCU has placed increasing emphasis on the process of moving promising technologies from the laboratory to the marketplace as a means of enhancing the sustainability of the institutes. The heightened recognition of the importance of commercializing research and the less favourable commercialization environment throughout the CIS, has led the research institutions to seek new ways of accomplishing the goal. One approach has been the increase in partnering activities between the research institutions and governmental and non-governmental organizations within the STCU Donor States.

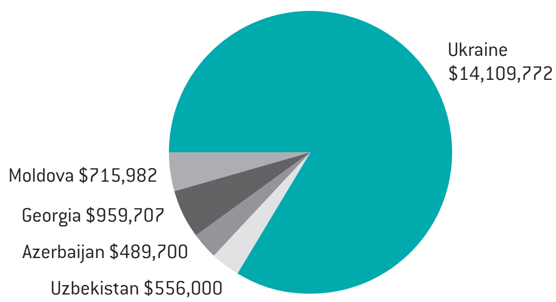
The Table below shows the change in STCU project funding during the period 2000 – 2007.



Since 1995, the Western Funding Parties have used STCU to manage over 1200 R&D projects, worth more than $170 million. The chart below shows the level of funding for Regular Projects in 2007 and the scientific research areas covered.



The chart below shows the distribution of research financing amongst the Recipient States, in 2007.



To date, the results that have been achieved have demonstrated the value of STCU as a central organizational point for multi-lateral cooperative security enhancement.

In 2005 the Science & Technology Centre in Ukraine (STCU) launched a new programme that was designed to integrate STCU's non-proliferation objectives with the Recipient Parties S&T priorities. The new program, incorporated the important lessons learned from more than 12 years of engagement of FWS from across the region. 'Targeted Initiatives' (TI) has succeeded in using STCU's existing mechanisms to attract Ukrainian, Georgian and Azeri political & financial support in redirecting FWS and other scientists into the country's long-term S&T development programmes. With this program, the STCU Recipient States are engaged as equal and active partners in co-financing research projects, in areas of national priority. Moreover, the new program is helping institutes / technical teams establish international linkages with the aim of bringing promising technologies to global markets.

A summary of funding provided by Canada, European Union and the USA in support of the Targeted Initiatives programme in Azerbaijan, Georgia and Ukraine is shown below. Also shown are the total number of scientists engaged and the proportion of Former Weapon Scientists. It is important to note that the level of financial commitment was matched by the Recipient States.

Total # of Projects	USD$ Funding	€ Funding	Number of Scientists Engaged	Number of FWS Engaged
60	Total $1,609,241	Total € 628,160	Total 756	Total 459 (61%)

In conclusion, stemming brain drain is directly linked to ensuring sustainability of former WMD scientists (and their institutes) which calls for engagement and building capability in areas of distinct competence. Towards this goal, STCU's programmes have been successful. The portfolio of programmes has been used to:

- raise awareness on the international stage of the depth & breadth of research within the Recipient States;
- facilitate exchange of scientific and technical information locally, regionally and internationally;
- facilitate scientific and commercial linkages with the goal of bringing promising technologies from the laboratory to the marketplace;
- identify priorities and develop research initiatives (involving both the Donor and Recipient States) around these priorities ;
- identify gaps where expertise is lacking and remedy the deficiency, for example through the development of new programmes;
- successfully interact with Recipient Government organizations to build stronger more coherent innovation infrastructure whilst engaging former weapon scientists.

Young Scientists' Involvement in the Decision-Making Process in Latvia: a Step to Stem 'Brain Drain'

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Association of Latvian Young Scientists

Increase of researcher's mobility between countries and institutions is one of the priorities of the European Research Area but in the same time the loss of young specialists because of brain drain is unwanted in Latvia. Young scientists are one of the groups for which brain drain is especially common. Due to their good knowledge of foreign languages and to their interest in mobility it is easy for young people to start a career in another country.

The Association of Latvian Young Scientists (ALYS) is a nongovernmental organization in Latvia that unites doctoral candidates and young researchers in Latvia on volunteer basis. ALYS is a leading organization in coordination issues of concern to young scientists and doctoral candidates. ALYS has become an official spokesman expressing the view of young scientists and protecting their interests. ALYS seeks to improve the mutual dialogue of young scientists with public and governmental authorities and to strengthen cooperation among young scientists. ALYS has three main work directions:

- Science popularization (for non scientific public – for pupils and students, ordinary people, for business people, etc.);
- Promoting the development of a high level scientific society (formal and informal events, improvement of legislation, international contact development, lobby in government and parliament, etc.);
- Fund rising for young scientists (finance from government, EU funds, 7th FP, international projects, donations, cooperation with business sector).

ALYS works also at international level as the representative of Latvian young scientists in the European Council of doctoral candidates and of young researchers (EURODOC) and World Association of Young Scientists (WAYS).

Since its establishment ALYS collects opinions form young scientists about science situation in Latvia as well as their work experience research abroad. Besides other reasons for leaving Latvia, like better financial conditions and superior laboratory equipment, young scientists accent low ability to participate in science decision-making process. From the one side, the scientific community is small in Latvia, but from the other side, there are long-term traditions in formal and informal mechanisms of decision making in science policy that makes it difficult for young scientists to take an active role in the decision making process individually.

Decisions in science are made at several levels in Latvia:

1. Research group;
2. Laboratory/department;
3. Institution;

4. Council of Science;
5. Ministry of Education and Science;
6. Cabinet of Ministers;
7. Parliament.

At the first level, decisions concern mainly research methods or approaches; at the second level, decisions can be about research projects and also funding for certain projects or experiments; and at third level, decisions taken concern research directions and finance distribution between different units. In these first three levels young scientists can participate individually. In the levels four, five, six and seven decisions are made in science policy, science budget, large research project finance and science administration. These are levels where ALYS take an active role as a social partner of decision makers to represent interests of young scientists.

To increase the involvement of young scientists in decision making process in Latvia ALYS takes initiative in representing the benefits of the involvement of young scientists in decision-making process in different decision-making levels starting from universities to the Parliament of Latvia and to the young scientists also. Individually members of ALYS are encouraged to participate in council or board meetings of their research institutions (in case where there are not closed meetings), as well us to take an active role in discussions related to finance and project administration issues in their research groups. To develop ALYS position on political level opinions of individual members of ALYS on certain issue are combined and discussed till consensus. The official opinion is based on the compromise as different science fields can have different points of view. This mechanism allows young scientists to contribute on improvement of strategic parts of science policy in Latvia as well as improvement of practical issues in their research institutions.

There are certain benefits for young scientists of participation in decision making process as well as positive effects on whole scientific community in the country, i.e.:
- deeper understanding about science policy and science project funding schemes;
- possibility to implement their knowledge and ideas in science management improvement;
- increased knowledge about other science disciplines;
- bonus for the future scientific career.

Effects on scientific community:
- improvement of transparency in science funding and policy;
- decrease of average age of scientists;
- increase of scientists returning from work abroad;
- increase the number of young people willing to work in science.

The involvement of young scientists in the decision making process can not been considered as a 'magic cure' to stem brain drain, but can be used as one of the first steps to make a signal for young scientists that decision makers are ready to work on improvements in science policy and the opinion of young scientists is important. The awareness that young scientists can affect local and national science decision making process and directions of research development is one of the motivating factors to stay in their fatherland, to make their scientific work and to contribute to the development of scientific community.

Problems of Measurement of the Real Brain Drain in the Post-Soviet States: the Ukrainian Case

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Existing statistics of scientific emigration in the post-Soviet States does not reflect the real size of outflow of specialists from these countries. Statistics include data only about 'pure' emigration of scientists and engineers. For instance, according to the recent data, only 14 researchers have emigrated from Ukraine in 2007[34]. It is in a great contrast with the early 1990s, when the number of emigrants was at the level of several hundreds persons per year[35].

However, emigration among scientists was a serious problem for all post-Soviet States. Losses from emigration are already significant in the Ukraine. A significant number of scientists emigrated from the country during 1990s. The estimates are based on the assumption that 9-11% of all emigrants are former employees of the R&D sector. About 1% of all emigrants are specialists with scientific degrees. According to official data about five to six thousand scientists emigrated from Russia and Ukraine in recent years. These figures do not appear to be very high. However, in some sectors the losses are particularly significant. As sociological surveys show, the proportions of specialists in mathematics, physics and biology among emigrants from research institutes are extremely high. That means that for some specific areas the losses were critical. Russia loses about 300,000 USD with the emigration of each scientist[36]. No reason to think that loses for Ukraine are lower. Among emigrants from Ukraine, mathematicians and specialists in software dominate (52%), while biologists hold second place with 27%.[37]

First of all, it would not be right to mention 'pure' emigration only. There are other forms of migration of highly-qualified specialists from key scientific institutions. A growing number of scientists use unofficial channels (that is to say channels that are not under the control of administrators of the research institutes) to go to the West. They participate in training programmes, receive stipends from foundations, and so on, without even consulting with the heads of their institutions. Such behaviour could not have been imagined in the former Soviet Union. 'Shuttle visits' and part-time work in the West has become more popular in the

[34] State Committee of Statistics of Ukraine (2008) *Naukova ta innovatsiyna dialnist v Ukraini. Statistichnyi Zbirnik*, Kiev, p. 74 (in Ukrainian).

[35] Klochko Y. (1994) 'Utechka Specialistov yz Naychnyh Organizaciy Ukrayny', *in Science and Science of Science.* N. 1-2, p. 173-180 (in Russian).

[36] Yurevich A.V., Tsapenko I.P. (1998) 'Intellectual Emigration from Russia', in Vestnik RAN, N.7, p. 692-703 (in Russian).

[37] Yegorov I., et.all., (2006) *Scientific and Innovation Activities in Ukraine in the Context of Eurointegration*, Derzhkomstat, Kyiv, 231 p. (in Ukrainian).

post-Soviet countries. Ukrainian (and Russian) statisticians have even introduced special statistical form to 'catch' this type of migration. According to the recent data, more than seven hundred scientists spent abroad more than 3 month per year in 2007. 'Shuttle migration' has become the predominant type of migration in Ukraine.

Speaking in general, over the last ten years several new trends have appeared in the pattern of emigration.

First, emigration has become 'professional' rather than 'ethnic'. There is strong evidence of an outflow of specialists irrespective of nationality from Ukraine between 1995 and 2007. For the first time, Ukrainians began to receive permission to emigrate to developed countries under the classification of specialists, rather than as refugees or family members.

Second, the will to emigrate has grown stronger among young scientists. Many young people are trying to pass exams to enter Western Universities or to receive long-term working contracts in the West. As a result, young specialists may leave their countries even before they officially start their scientific careers, thus making it difficult to reflect this phenomenon in the statistics on scientific emigration. Surveys and statistical data from official statistical forms could not catch these emigrants. We have no exact data but the best University departments report about 10-15% of their students, who emigrated. The intention to emigrate among young specialists is even higher but the decline of the quality of education in Ukraine prevents them to leave the country. It is still much lower than in Russia, where more than 60% of graduates from the most prestigious technical universities emigrated in 1990s- first half of 2000s. The problem with this emigration is that the chances for this group to return to their home country are much lower than for the older groups of the specialists.

In addition, similar situation is with the gender distribution of emigrants. If in the past, it predominantly 'male's behaviour', now above one quarter of all emigrants among scientists are women, and their share is growing rapidly. Junior women are more mobile than those with families and for them it is much easier to emigrate, as they usually have talents to foreign languages. Recent competition for masters stipends in the USA among Ukrainian students showed that two thirds of applicants were young women. Chances for their return to Ukraine after the finish of their education are especially low, as the statistics of participation in these programmes shows.

Third, there has been change of direction in emigration in the case of Ukraine. From the second half of the 1990s, a remarkable number of specialists left Ukraine for Russia - mainly from the military-industrial complex and the nuclear energy industry. To a great extent, this was because the difference in salary between specialists in Russia, particularly in the nuclear energy sector or in some military-oriented companies, and their Ukrainian counterparts was very substantial. The process of emigration to Russia is not primarily a result of ethnic problems. The introduction of the Ukrainian language, as the one and the only official State language in Ukraine, met with a negative reaction on the part of the Ukrainian research community. Traditionally, the bulk of scientific literature was published in Russian, and dissertations and papers were also written in Russian.

At the same time, some researchers, especially from the Western regions of the country left Ukraine for Poland and Hungary. In the first case, it was a 'substitution' of Polish specialists, who left the country for the West, while in the second - the result of creation of Hungarian colleges in Ukraine and the so-called 'Law on Hungarians', passed in early 2000s by the conservative government of M. Orban in Hungary.

Fourth, large corporations have started to play more important role in the process of emigration than universities. They are responsible for the lion's share of emigration of qualified specialists now.

It would be important to mention so-called 'semi-emigration', which is also growing quickly in Ukraine in recent years. Many specialists are working for foreign companies without changing the place of their residence. This could be called 'an-early-Bangalore-type' of migration, where specialists are working purely for external market without any connection with domestic production, and even without paying taxes in the home country. They send their results electronically to the company and receive money on their accounts. The country of residence loses not only tax payments, in some cases it could not receive revenues for intellectual property.

However, it is important to stress that the problem of the internal relocation of educated personnel is more serious than the problem of emigration, as many more specialists left the R&D sector for other types of activities than emigrated from the country. Low wages and lack of demand for intellectual products have led to an outflow of hundred thousands of educated people to other sectors of the national economy, and primarily to private business. This process could not be considered as purely negative, because the effectiveness of the whole economy could rise as a result. The pressure on the State budget is eased and preconditions for co-operation with former colleagues from R&D institutions are usually maintained. The diffusion of former researchers from R&D into other sectors could bring positive results at the present stage of economic recovery. Unfortunately, the great majority of former scientists have undertaken relatively simple work that does not require the scientific qualifications that they possess. Total number of employees in R&D declined by more than half, while the manufacturing sectors of Ukrainian economy have great problems with organizing of effective production.

Conclusion

There is no 'pure' strategy in any real life decision-making process and compromises are essential to solve the problem of emigration.

The first and evident step is to improve the practice of surveying the migration processes. To some extent, it is made already by introduction of the new statistical forms. However, extra efforts, including specialized surveys have to be made 'to catch' better new phenomena in migration processes.

Science can and must play a more significant role in the transition economy. It is a great mistake of the Ukrainian leaders, as they neglected the problems of S&T sector for years and concentrated their efforts on short-term economic stabilisation only.

Ukrainian science and technology can find its own niches, which could provide benefits, including income from export, without wasting natural resources in such volumes as takes place today.

The basic problem is to provide sufficient demand for R&D products during the transition. Privatisation policy will be a key measure. Serious reforms of the R&D sector are needed. In the end, it does not matter, whether industrial enterprises absorb R&D laboratories or research institutions buy factories: the important point is that they have to be integrated. In-house industrial research, most of which is closely linked to the production process, is the cornerstone of R&D in the market economy.

In any case, further large-scale cutbacks are inevitable in the R&D sector in the near future in the light of economic crisis. At the present time state officials are seeking to preserve social stability and do not reduce staff and nominal salaries. But if a more efficient system is to be created, this hidden unemployment has to be brought out into the open in the near future. This will lead to the new wave of emigration from the country, especially among young persons. To 'soften' the problem several steps have to be made:

1. Offering State protection to some selected S&T areas which could establish globally competitive positions for national science and technology. In practice this is very difficult to implement. It would have to be based on independent evaluation procedures (as in Germany, for example), with participation of Western experts. Alternatively, grants for research could be distributed by national bodies, but with random checking from Western experts. This procedure would not be so expensive.
2. Restructuring sources of research funding in order to destroy the monopoly in distribution of financial resources. The present system of distribution is unfair and inflexible and gives priority not to the best, but to the 'well-positioned' administrators within R&D sector.
3. Developing an 'educational wing' within research institutes. Currently the Academy of Sciences accounts for less than 20% of all post-graduate students. Academy institutes could be converted into graduate universities with strong research departments.
4. Further development of exchange programmes and scientific contacts, including 'legalization' of 'shuttle migration' based on the establishment of new, and the strengthening of existing relations with scientific institutions of other countries, including developing countries and encouragement of the development of inter- institutional contacts with specialists from other countries.
5. Conducting the 'technological' part of laboratory experiments, etc. for Western partners. The particular emphasis on this point is based on the recognition of the disastrous condition of research equipment and the comparative surplus (comparing to GDP) of research personnel in Ukraine. Getting the necessary equipment in exchange for various services could be a way of recovering from relative technological backwardness.

6. Invitation to international research organisations and their divisions to establish units in Ukraine. The experience of the Trieste and the St.-Petersburg Euler international mathematical institute and of some others, demonstrates that setting up international research centres can help to boost R&D activities.

But international co-operation can only be an important supplement to internal structural transformations in Ukrainian R&D sector. This will only be possible if the authorities really start economic reforms, which would induce demand for R&D production in Ukraine. Otherwise, this potentially rich country with S&T traditions will turn into a less developed country during one generation).

General Bibliography

- Alberts, B. (2004) Science Education: *No bigger Challenge for Science and Scientists Everywhere*, Promoting Science, Education and Society: The Academy-Government Challenge, The Israel Academy of Sciences and Humanities, Jerusalem.
- Bangemann, M. (1994) *Europe and Global Information Society*. *Report to European Council*, 24-25 June, (translated into Romanian in the *Romanian Magazine of Informatics and Automatics* (PRIA), 4(2-3), P.2-26).
- Bide, M. (2001) *Business Models for Distribution Archiving and Use of Electronic Information: Towards a Value Chain Perspective*, Mark Bide &Associates.
- CELIP (2001a) *Accesul la resursele electronice. Aspecte privind licențele în biblioteci* (http://www.eblida.org/celip/workshops/romania_agenda.html) (in Romanian).
- CELIP (2001b) *Licensing issues for Central and Eastern Europe* (http://www.eblida.org/celip/workshops).
- Cristea M. (1996) 'S-ar putea face mai mult în privința popularizării patrimoniului național' in *Computer World Romania*, April, p. 9.
- CULTIVATE (2001) (http://www.cultivate-eu.org).
- De Michelis (1996) 'VENIVA ESPRIT Project and the cultural heritage as a natural resource in the 21st Century', in *Proc. EVA'96*, Cappelini V. and Hemsley J. (Eds.), Florence.
- Dertouzos, M. (1991) 'Building the Information Marketplace', in *Technology Reviews*, 94 (1), p. 29-40.
- Dertouzos, M. (1997) *What It Will Be*, Harper Edge, New York.
- Digicult (2001) *Key Background Information and the Cultural Heritage* (http://www.cordis.eu/ist/ka3/digicult/en/bactgrd.html).
- DigiCULT (2001) *Digital Heritage and Cultural Content* (http://www.cordis.eu/ist/ka3/digicult.htm).
- Djurovic, M. (2008) *National academies and competitiveness. Towards regional competitiveness in SEE*, BAS, Sofia 4-5 April.
- Djurovic, M. (2006) *Whose responsibility is greater?*, The meeting of SEE National Academies, Tirana, 2006.
- Docquier, F. and Marfouk. A. (2006), 'International Migration by Educational Attainment (1990-2000)' in Özden C. and Schiff, M.W. (Eds.), *International Migration, Remittances and the Brain Drain*, Palgrave-Macmillan, London, p. 151-200.
- Drenth, P.J. (2005), *Scientific integrity and social responsibility: The role of Academies of Sciences*, ALLEA, Annual report.
- Dumont, J.C., Martin, J.P. and Spielvogel, G. (2007) *Women on the Move: the Neglected Dimension of the Brain Drain,* Institute for the Study of Labour (IZA), Discussion Paper Series, IZA, Bonn.
- EAN (2001) The European Archival Network (http://www.european-archival.net).
- EC (European Commission) (2001) *Cultural Heritage in FP6* (http://www.cordis.eu/ist/ka3/digicult/en/fp6.html)
- EC (European Commission) 2000 a) *eEurope+ for Candidate Countries* (http://europa.eu.int/information_societz/eeuropa/index_enhtm).
- EC (European Commission) 2000 b) *eContent*, Press Release/22.17.00.
- EC DGXIII/E-4 (1991) *Report on the Situation of Libraries, Museums and Archives in the EU Member States and EFTA Countries* (http://www.eu/libraries/en/nfp/introd.html).
- eContent (2001) *European Content on Digital Networks* (http://www.cordis.eu/econtent).

- eCulture (2001) *A Newsletter on Cultural Content and Digital Heritage* (http://www.cordis.lu/ist/ka3/digicult/en/newsletter.html).
- EVA (2001*) The Florence Agenda: Trends and Future Developments in ICT for Culture and Science* (http://www.cordis.eu/ist/ka3/digicult/en/florena-agenda.html).
- Filip, F.G. (1995) 'Tehnologiile Informatice pentru Procesele Lucrative', in *Academica*, An V, 6 (154), p. 20-21 (in Romanian).
- Filip, F.G. (1996) 'Information Technologies in Cultural Institutions' in *Studies in Informatics and Control*, *sic,* 6(14), p. 385-400.
- Filip, F.G., D. Donciulescu, F. G. Filip (2000) 'A cybernetic model of Computerization of the Cultural Heritage', in *Proceedings of the 8th IEEE Mediterranean Conference on Control & Automation - MED 2000, Patras*, July 17-19 (CD-ROM).
- Filip, F.G., D. Donciulescu, Carmen Sauer (1996). Towards cultural integration of Romania by using information technology. In *Procedings Electronic and Virtual Arts-EVA'96*, Paris, Vol. 4, p. 45-50.
- Filip,F.G. (1996) 'Tehnologiile informaţionale şi valorificarea patrimoniului cultural naţional' in *Academica*, An VI, 9 (69), p. 22-24 (in Romanian).
- FN (1998) 'Convergence in the Digital Age: Challenges for Libraries, Museums and Archives', in *Proceedings of the Seminar*, held in Amsterdam, 13-14 August.
- F.N. (2001) 'Library Management Systems', in *Managing information*, 8 (3), April, p. 32.
- G7 (1995) *Information Society Conference. Pilot Projects, Executive Summary*, Brussels, 25-27 February.
- Klochko Y. (1994) 'Utechka Specialistov yz Naychnyh Organizaciy Ukrayny', *in Science and Science of Science.* N. 1-2, p. 173-180 (in Russian).
- Lowell, B. L. (2002) *Policy Responses to the International Mobility of Skilled Labour,* ILO International Migration Papers, nr. 45, ILO, Geneva.
- Martin, C. (1998) 'The time dynamics of future publishing', in *Blueprint to the Digital Economy. Creating Wealth in the Era of e-Business*, D. Tapscott (Ed.), Mc.Graw Hill, New York.
- Matei, D. (1996) *Crearea infrastructurii informaţiei a instituţiilor culturale din România*, CIMEC Bucharest (in Romanian).
- Glenn, J.C. and Gordon, T. J. (2007), *State of the Future*, Millennium Project.
- Neamţu, L. (1996) 'Punct de plecare: cabinetul de manuscrise rare al Bibliotecii Academiei. Punct de sosire: plasarea României pe orbita Internet', in *Totuşi iubirea*, VIII, Nr. 26/27, p. 24-25.
- NSF (1998) *Digital Libraries Initiative. Phase2* (http://www.nsf.gov/pubs/1998/nsf9863/nsf9863.htm).
- IOM (2008) 'Highly Skilled Migration' in *World Migration Report*, IOM, Geneva.
- OECD (2004) *Trends in International Migration. Annual Report*, SOPEMI, OECD, Paris.
- OECD (2006a) *International Migration Outlook*, SOPEMI, OECD, Paris.
- OECD (2006b) *Education at a Glance 2006*, www.oecd.org/dataoecd/46/0/37368660.xls.
- Review, 36(2), p. 25-40.
- Saltzer, J.H. (1992) 'Technology networks and the library of the Year 2000', in *Future Tendencies in Computer Science, Control and Applied Mathematics*, Bensoussan, A. and Verjus J.P. (Eds.), Springer Verlag, Berlin, p. 51-67.
- Salzburg Research (2001) *Europe's Memory Institutions on Their Way into the digital Cultural Economy*, DigiCULT Study (http://www.salzburgresearchat/fbi/digicult/start.html).
- Shoemaker, P.J.H. (1995) 'Scenario planning: a tool for strategic thinking', in MIT *Sloan* Management
- State Committee of Statistics of Ukraine *(*2008) *Naukova ta innovatsiyna dialnist v Ukraini. Statistichnyi Zbirnik*, Kiev, p. 74 (in Ukrainian).

- TEL (2001) The European Library (http://www.europeanlibrary.org).
- TfL(1998) Telematics for Libraries (http://www.cordis.eu/libraries/en/libraries.html).
- *Ubuntu Declaration on Education and Science and Technology for Sustainable Development*, World Summit on Sustainable Development, Johannesburg, South Africa, 26 August - 4 September 2002.
- UNESCO Institute for Statistics (2006) *Global Education Digest 2006. Comparing Education Statistics Across the World,* Montreal.
- Vincent-Lancrin, S. (2008), 'Student Mobility, Internationalization of Higher Education and Skilled Migration', in *World Migration Report*, IOM, Geneva.
- World Bank (2006) *Global Economic Prospects, Economic Implications of Remittances and Migration,* The International Bank for Reconstruction and Development/The World Bank, Washington DC.
- Yurevich A.V., Tsapenko I.P. (1998) 'Intellectual Emigration from Russia', in Vestnik RAN, N.7, p. 692-703 (in Russian).
- Yegorov I., et.all., (2006) *Scientific and Innovation Activities in Ukraine in the Context of Eurointegration*, Derzhkomstat, Kyiv, 231 p. (in Ukrainian).
- (2001) *The Lund Principles. Conclusions of Expert Meeting*, Lund, Sweden, 4 April 2001 (http://cordis.eu/ist/ka3/digicult/en/eeurope.html).

Conference Declaration

For the regions, the Conference recommends that mechanisms should exist at national level for regular exchange of information and experience between decision-makers and the scientific community. These mechanisms should assist the decision-makers in formulating science- and education policies, and thus contribute to the creation of knowledge-based society.

The Conference recommends that the National Academies of Sciences takes the lead in this process at national level. The Academies must ensure that the entire scientific community is included in this process.

The Conference invites UNESCO and CRDF to convene a follow-up meeting within two years to assess the progress of these recommendations' implementation.

The Conference urges major fund-providers (European Commission, National Governments, donors, international foundations, etc.) to allocate dedicated funds to support the implementation of the above recommendations, both at national level and supra-regionally.

ANNEX II

Final Communiqué

As a follow-up to the International Conference of the Academies of Eastern and South Eastern Europe on *'Global Science and National Policies: the Role of Academies'*, organized by the UNESCO Office in Venice (BRESCE), the UNESCO Office in Moscow and the International Council for Science (ICSU) hosted by the Academy of Sciences of Moldova in Chisinau, Republic of Moldova (4-5 May 2007), the International Conference for the Central and Eastern Europe, Balkans, Caucasus and Baltic States on *'Science and Education Policies'* was held in Chisinau, from 18 to 21 September 2008. The Conference was organized by joint efforts of the Academy of Sciences of Moldova and the Ministry of Education and Youth of the Republic of Moldova, with the support of the UNESCO Office in Moscow, Central European Initiative, the U.S. Civilian Research and Development Foundation (CRDF), Office of Naval Research Global (ONRG) and Moldovan Research and Development Association (MRDA), among others.

This event, officially included in the Calendar of Events of the Moldovan Presidency to the South East European Co-operation Process (SEECP), brought together key leaders and policy makers at the highest levels in science and education: Presidents of the Academies of Sciences and Ministers of Science and Education, participating or represented, as well as representatives of international organizations from the above-mentioned regions, including representatives of the European Commission and experts from the United States.

The programme of the Conference addressed several challenges affecting science and higher education policies today, mainly: strengthening international impact of national research and education programs; strengthening research in higher education; developing a knowledge-based economy; stemming and reversing brain drain.

Following the presentations and discussions held during the sessions addressing the above themes, the participants agreed that:

1. An increased attention to the synergy between research and higher education in developing national science and education policies plays an essential role in the building of a sustainable knowledge-based economy;

2. Excellence in knowledge management can be acquired only by strengthening the international impact of national research and education programmes, by fostering international cooperation at bilateral and multilateral levels;

3. The topics of interest and the problems faced are similar across the regions targeted by the Conference, and that great benefit could be obtained from exchanges of best practices, benchmarking activities, joint actions and programmes for regional cooperation, horizontal support activities with considerable regional relevance and other actions which require cooperative efforts;

4. A stronger link between the education field and that of research-development-innovation will result in a qualitative improvement of the education process, increasing the access of students and academic staff to the state-of-the-art scientific investigations and creating opportunities of operative orientation of the education towards the tendencies of development of science at an international level;

5. A robust and healthy science community, capable of solving problems of global importance, can be acquired only in the case when research and education work hand in hand;

6. Informal science education is as important as the formal one, which would enable the society to make proper use of the scientific knowledge as well as to face threats associated to it, especially in nuclear physics, biotechnology, nanotechnology, thus to preserve not only the environment but also many human lives;

7. Interdisciplinary education and, consequently, research can't be avoided in the generation of new knowledge today, therefore fostering interdisciplinary communication and building bridges across sectors and disciplines is imperative;

8. The connection between higher education and science is primarily established by the legal framework. The research activities within the faculties should be supported, strengthened and enhanced;

9. The young generation of scientists plays a crucial role in fostering the knowledge society and therefore their implication in the processes of decision and policy-making is of great significance;

10. A special focus in developing science and education policies needs to be placed on high skilled mobility issues, encouraging on the one hand international mobility of talents and on the other mitigating the negative effects of 'brain drain';

11. Participants attested positive changes in the national education systems, after the adoption of the Bologna Process principles and welcomes the reforms launched in the education field of the Republic of Moldova.

The participants acknowledged that a specific comprehensive programme of actions related to science and education management is necessary both at national and regional levels. In conclusion, the participants asked UNESCO, the European Commission and other international organizations, as well as national authorities, to consider the following recommendations in developing science and education policies:

1. Open up national programmes and institutions to participants from other countries, thereby encouraging own researchers to compete and collaborate with the best talents;

2. Create and support specific incentives in national research funding schemes for engaging researchers in cross-border research cooperation;

3. Reinforce research cooperation agreements with third countries and international organisations to exchange best practices, identify common priorities and potential benefits, and jointly define and implement research and education programmes;

4. All stakeholders involved, especially national governments, should give a high priority to human capital improvement by means of education, and assurance that knowledge is engaged in all fields of national economy and that easier access to scientific information is provided;

5. Promote the development of centers of excellence for scientific research and education and frame the conditions for innovation and high tech entrepreneurship, therefore making the country attractive to highly skilled workers, both within the country and from outside;

6. Contribute to regional, supra-national centers and networks to increase priority setting;

7. Collaborate to ensure that the economic and intellectual benefits arising from the growing international mobility of researchers and students are enjoyed by all who have contributed to its realization, make existing rules and procedures for international cooperation of scientists more simple;

8. Support the creation and maintenance of intellectual/scientific diaspora networks and cooperative projects between expatriates and their home country, expand virtual and distant learning opportunities and promote real and virtual return of talent programmes;

9. All stakeholders, especially national governments, should play specific attention in policy making to programmes and measures to stimulate young people to enter the field of research and education;

10. Undertake measures of substantive inclusion of the business sector in financing of the research by using the scientific knowledge and results in their own spheres and of course, raising the state participation in the funding process of research and development in higher education;

11. Formulate conditions and mechanisms to encourage innovative entrepreneurship initiatives, initiate measures (establishing a framework agreement) for commercialization and transfer of intellectual property rights, as well as strengthen regional know-how exchange and joint trainings on developing transfer of technology skills;

12. Support awareness raising and encourage the building of bridges between knowledge and its perception by the general public, as well by the national decision-makers;

13. Acknowledge the role of national academies, along with research councils and foundations, in science policy and in contributing to the creation of the knowledge-based society;

14. Convene joint meetings of decision-makers with science and education representatives on a regular basis and enhance communication in the intervening period, both at national and regional levels.

This document constitutes a contribution of the Central and Eastern European countries, Balkans, Caucasus and Baltic States to the World Conference on Higher Education (Paris, July 2009) and World Science Forum (Budapest, November 2009).

ANNEX III

Programme of the Conference

Friday, 19 September 2008

Chairpersons: Gheorghe DUCA, President of the Academy of Sciences of Moldova
Larisa ŞAVGA, Minister of Education and Youth of Moldova

Welcome: Vladimir VORONIN, President of the Republic of Moldova
Reforms & Perspectives for Development of Science and Education in the Republic of Moldova
Zoran STANČIČ, Deputy Director-General of DG Research, European Commission
Engelbert RUOSS, Director, UNESCO BRESCE
Pietro Ercole AGO, Secretary General of the Central European Initiative
Eric NOVOTNY, Senior Vice President, U.S. Civilian Research & Development Foundation
Dendev BADARCH, Director, UNESCO Moscow Office
Valeriu OSTALEP, SEECP Chairman, Deputy Minister of Foreign Affairs and European Integration

Press-Conference

SESSION I: Strengthening International Impact of National Research & Education Programmes

Chairpersons: Momir DJUROVIC, President of the Montenegrin Academy of Sciences and Arts
Vanya DOBREVA, Deputy Minister of Education and Science of Bulgaria

Rapporteur: Zoran STANČIČ, Deputy Director-General of DG Research, European Commission
The Challenge to Strengthen the International Impact of Research and Education Programmes and How the European Community's 7th Research Framework Programme Has Answered It

Speakers: George BONAS, Adviser for S&T, International Centre for Black Sea Studies
Bilateral and Multilateral Cooperation Activities: Key Factors and Synergies
Huntington WILLIAMS, III, Director, The Washington Advisory Group
The Global Research Partnership of KAUST: A Model for Research Universities in the 21st Century
Zoran KOVACEVIC, President of Novi Sad Branch, Serbian Academy of Sciences and Arts
Some Important Questions Concerning Development of Research and Education in Serbia

Adila KRESO, University of Sarajevo, Academy of Sciences and Arts of Bosnia and Herzegovina
Achieving the Teaching Goals of Bologna Process in Higher Education in B&H, and Neglecting Research Programmes and Policy
Jaan KÕRGESAAR, Head of Higher Education Department, Ministry of Education and Research of the Republic of Estonia
Estonian HE and R&D Policy, 1992-2008
Karen K. OATES, Deputy Director of the Division of Undergraduate Education, U.S. National Science Foundation
Research and Education: Supporting Integration for Discovery and Student Learning

SESSION II: Strengthening Research in Higher Education

Chairperson: Engelbert RUOSS, Director, UNESCO BRESCE
Mikhail ITKIS, Vice Director of Joint Institute for Nuclear Research

Rapporteur: Michael SCHLICHT, Federal Ministry for Education and Research, Germany
The Impact of Research on the Development of Higher Education

Speakers: Pietro Ercole AGO, Secretary General of the Central European Initiative
Marjorie SENECHAL, U.S. Civilian Research & Development Foundation Board Member
A 10-year U.S.-Russian Collaboration in Research and Higher Education
Teki BIÇOKU, President of the Academy of Sciences of Albania
Contribution of Academy of Sciences of Albania on Strengthening Research in Higher Education
Gheorghe DUCA, President of the Academy of Sciences of Moldova
Education through Research: Educational-Scientific Cluster of ASM 'UnivER SCIENCE'
Momir DJUROVIC, President of the Montenegrin Academy of Sciences and Arts
Science for Education & Education for Science
Larisa ŞAVGA, Minister of Education and Youth of the Republic of Moldova
Vlado KAMBOVSKI, Vice-president of the Macedonian Academy of Sciences and Arts
Macedonian Approach to Strengthening the Research in Higher Education
Atanas ATANASSOV, Scientific Secretary of the Bulgarian Academy of Sciences
Science and Higher Education in Bulgaria in Searching of Common Perspectives
Valéria CSÉPE, Deputy Secretary General of the Hungarian Academy of Sciences
How to Facilitate Professional Research in the Hungarian RT
Revaz ASATIANI, Head of Science Division, Georgia National Science Foundation
GNSF as a Key Player in Reforms of S&T Sector in Georgia

Saturday, 20 September 2008

SESSION III: Developing a Knowledge-Based Economy

Chairperson: Cristian ADOMNIŢEI, Minister of Education, Research and Youth of Romania
Tarik CELIK, Vice-president of the Turkish Academy of Sciences

Rapporteurs: Václav PAČES, President of the Academy of Sciences of the Czech Republic
Research as a Driving Force for Economic and Social Growth
Dr. Eric NOVOTNY, Senior Vice President, U.S. Civilian Research & Development Foundation
Building a Knowledge-based Economy

Speakers: Mikhail MYASNIKOVICH, Chairman of the Presidium of the National Academy of Sciences of Belarus
Forming a New Economy in the Republic of Belarus
Aleksei SISAKIAN, Director of Joint Institute for Nuclear Research & Mikhail ITKIS, JINR Vice Director
Science – Education – Innovation: the basis for the development of scientific centres and state economy
Kenneth STOKES, Dean of the Tillman School of Business, Mount Olive College, North Carolina, USA
Global Open Innovation System. Mega-Clusters and the Knowledge-based Economy
Eugenijus BUTKUS, Chairman of Science Council of Lithuania
Linking business with science and technology – policy developments in Lithuania
Gennadiy PIVNYAK, Rector of the National Mining University of Ukraine
Cooperation between National Academy of Science, Universities and Business in Contest of Economic Knowledge Development
Florin FILIP, Vice-president of the Romanian Academy & Igor COJOCARU, Director of the Information Society Development Institute of Moldova
Information Technology and Cultural Heritage

SESSION IV: Stemming And Reversing Brain Drain

Chairperson: Eugenijus BUTKUS, Chairman of Science Council of Lithuania
Valentin ORLOVICH, Chairman of the Scientific Council of the Belarusian Foundation for Fundamental Research

Rapporteur: Christine AGHAZARM, International Organization for Migration
Stemming and Reversing the Brain Drain: a Global Perspective

Speakers: Vanya DOBREVA, Deputy Minister of Education and Science of Bulgaria
Common Problems that the SEE Region Faces in Terms of Brain Drain

Sergii PIROJKOV, Extraordinary and Plenipotentiary Ambassador of Ukraine to the Republic of Moldova
The Problem of Outflow of Young Researchers and Specialists: the Ukrainian Experienc
Landis HENRY, Deputy Executive Director (Canada), Science & Technology Centre in Ukraine (STCU)
Stemming and Reversing Brain Drain – A role for STCU
Gilbert FAYL, Secretary of External Affairs, European Academy of Sciences
Mobility of Talent: the Other Side of the Coin
Janis JASKO, Secretary General, Association of Latvian Young Scientists
Involvement of Young Scientists in Decision Making Process in Latvia - First Step to Stem Brain Drain
Igor YEGOROV, Centre for S&T Potential and Science History Studies, National Academy of Sciences of Ukraine
Problems of Measurement of the Real Brain Drain in the post-Soviet States: Ukrainian Case

Conference Conclusions and Recommendations

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A robust and healthy science community, capable of solving problems of global importance, can be acquired only in the case when research and education work hand in hand.

Interdisciplinary education and, consequently, research can not be avoided in the generation of new knowledge today; therefore, fostering interdisciplinary communication and building bridges across sectors and disciplines is imperative.

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(excerpts from the 'Final Communiqué', adopted by the participants in the International Conference *Science and Education Policies*, Chisinau, Republic of Moldova, 2008).

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