

Can Croatia Join Europe as Competitive Knowledge-based Society by 2010?

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The 21st century has brought important changes in the paradigms of economic development, one of them being a shift toward recognizing knowledge and information as the most important factors of today. The European Union (EU) has been working hard to become the most competitive knowledge-based society in the world, and Croatia, an EU candidate country, has been faced with a similar task. To establish itself as one of the best knowledge-based country in the Eastern European region over the next four years, Croatia realized it has to create an education and science system correspondent with European standards and sensitive to labor market needs. For that purpose, the Croatian Ministry of Science, Education, and Sports (MSES) has created and started implementing a complex strategy, consisting of the following key components: the reform of education system in accordance with the Bologna Declaration; stimulation of scientific production by supporting national and international research projects; reversing the “brain drain” into “brain gain” and strengthening the links between science and technology; and informatization of the whole education and science system. In this comprehensive report, we describe the implementation of these measures, whose coordination with the EU goals presents a challenge, as well as an opportunity for Croatia to become a knowledge-based society by 2010.

Not long after facing a devastating war and destruction (1-4), Croatia is striving to establish a knowledge-based society founded on international standards of excellence and openness (5,6). The previous 16 years, in which the country went through a turbulent transition from a communist regime to a democratic society and market-driven economy, were not a very productive period in the field of science and research. Less than half of Croatian scientists published their research findings in relevant scientific publications (7). In the 1999-2003 period, only 1745 articles per million pop-

ulation were published in internationally visible journals indexed in the Web of Science bibliographic database. This was only one of the indicators of inadequate management and insufficient funding in science and education sector, inherited from the communist days (8). In 2003, the reorganization and development of higher education, science and technology, and information society were approached in a structured and systematic way.

Toward knowledge-based society

The main strategic goal set by the European Union (EU) member states at the Summit in Lisbon in 2000 was for Europe “to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion” (9). At the core of the strategic reorientation of priorities at the Lisbon Summit was the recognition of education and training as essential for development of a knowledge-based economy and full employment. The Heads of State and Governments indicated that urgent modernization of education systems was the main prerequisite for the EU to by 2010 assume the leading position in the world in the quality of education and science system. However, carrying out this plan will not be easy, as non-EU countries will not stand idly by while Europe is moving toward its Lisbon goals (10). Although the reform process is a joint plan coordinated at the EU level through cooperation and shared efforts of the member states, it respects national differences and tradition of each country where it is implemented (9,11). The European Council also identified the need to set quantifiable targets, indicators, and benchmarks, such as 16 indicators on quality of school education (Box 1), as a means of comparing the best practice in member states and monitoring and assessing the progress.

Development of a knowledge-based society depends on the quality and continual improve-

Box 1. Sixteen indicators of education quality as defined by the European Commission (<http://ec.europa.eu/education/policies/educ/indic/rapinen.pdf>)

Area	Indicator
Attainment	mathematics
	reading
	science
	information and communication technologies (ict)
	foreign languages
	learning to learn
Success and transition	civics
	drop out
	completion of high school education
Education monitoring	participation in tertiary education
	evaluation and steering of school education
Resources and structures	parental
	education and training of teachers
	participation in pre-elementary education
	number of students
	educational

ment of the education and science system, complementarity and interaction between education and science, and informatization of the whole system. Like many other developed and developing countries in the world, the Republic of Croatia has also recognized these segments to be essential for development and entrusted the Ministry of Science, Education, and Sports (MSES) with designing and monitoring the implementation of almost all the measures that will “make Croatia a knowledge-based society and Croatian science and education sector the most competitive in this part of Europe by 2010” (12). For this purpose, a very complex structure of the MSES and associated organizations and institutions had to be developed and staffed with adequately trained people (Figure 1). The MSES itself is the result of merging two separate ministries, the Ministry of Education and Sports and the Ministry of Science and Technology, which took place on December 23, 2003. This was a crucial step for establishing previously non-existent vertical integration of education and science, ie, a com-

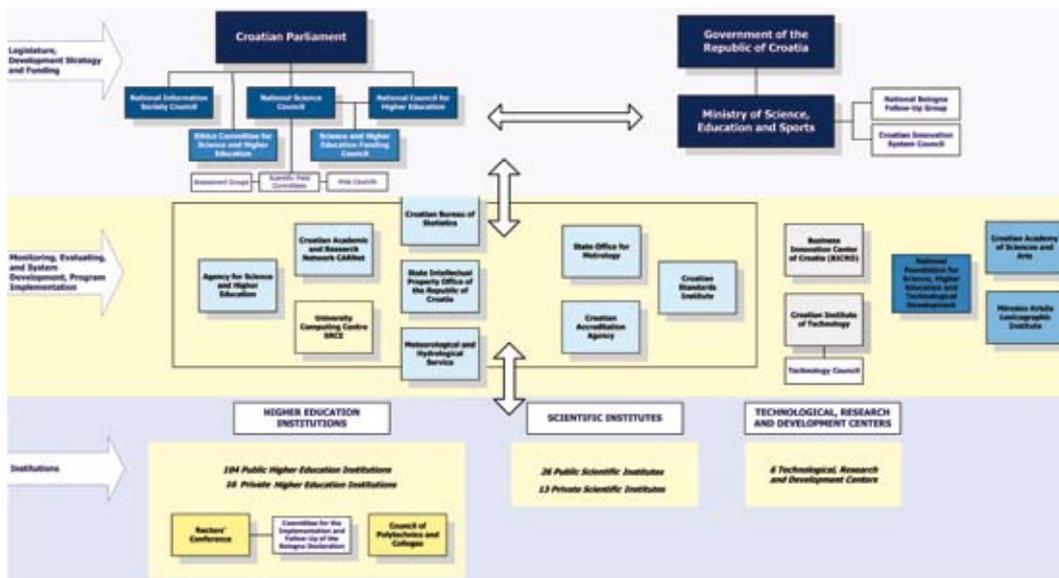


Figure 1. Organization of higher education, science and technology, and information society system in the Republic of Croatia (12).

Box 2. Priorities in Croatian education system (13):

- Interlinking all levels of education system, from kindergarten to doctoral studies
- Enhancing quality and effectiveness of education
- Encouraging continual professional development of teachers and other education staff
- Improving financial status of teachers as well as schools
- Building school, university, science, and sport facilities
- Education for social cohesion, economic growth, and development
- Aligning education with labor market requirements
- Creating student-centered education process

prehensive system encompassing an education vertical, ranging from preschool to higher education, doctoral studies, and lifelong learning (Box 2), with scientific and technological verticals: basic research – applied research – developmental research (13,14).

Education and science development strategy

Croatia has set out to close the gap between its own education and science system and that of the developed countries by implementing changes in the entire education system (13,15-19). On the one hand, these changes rely on the long tra-

dition of Croatian education and science system – Croatia had for centuries been a part of Habsburg Empire, which had a high-quality education system. On the other hand, the changes are based on modern educational experience and trends in European countries (20-26). These comprehensive modifications of the Croatian education and science system include introducing Croatian National Educational Standard (15) into 8-year elementary schools (elementary education in Croatia traditionally consists of a 4-year primary plus 4-year lower secondary education); introducing external evaluation (state examinations and high-school and vocational school graduation exams) (27); extending compulsory education from elementary to higher secondary education (11-12 years in total); introducing Bologna principles into higher education institutions (28); organizing lifelong learning system; bringing science and technology in closer alignment with European standards; establishing vertical education and science system, as well as new institutions and bodies for implementation of developmental goals (Figure 1); and enacting or amending relevant legislation (Table 1) (14). Five polytechnic schools have already been es-

Table 1. Croatian science, technology, education, and information institutions established by the Croatian Government and Croatian Parliament in the 2004-2006 period (in order of establishment)*

Institutions and professional bodies	Established on	Purpose and activities
I. Institutions		
Agency for Science and Higher Education	July 15, 2004	Evaluating institutions and programs in the science and higher education system Establishing a national network for ensuring quality in higher education Providing professional help to National Council for Science, National Council for Higher Education, and Science and Higher Education Funding Council Recognition of overseas higher education qualifications
Croatian Standards Institute*	October 27, 2004	Preparing and accepting Croatian standards and other standardization documents Maintaining a collection of standards and Croatian Standards Register
Croatian Accreditation Agency*	October 27, 2004	Accrediting science and measurement laboratories Accrediting legal and natural persons authorized to approve products, management systems, and personnel, as well as legal and natural persons in charge of technical monitoring and similar activities
Agency for Vocational Education	January 13, 2005	Modernization of vocational education in accordance with labour market needs Development, organization and monitoring of the secondary school vocational education Teacher training and certifications examinations
Karst Center	July 22, 2005	Running research and development projects, organizing professional meetings, and publishing in the field of research and economic development of Croatian karst areas The Center should involve a multidisciplinary group of scientists and experts and provide for a sustainable development and economic growth of karst areas
Croatian Institute of Technology - HIT Ltd	March 3, 2006	Established by reorganization and significant expansion of the activities of the Institute for Technologic Policy and Development Creating preconditions for quicker application of new knowledge and technology by providing services, expertise, and projects, with the purpose of creating a powerful economic growth based on knowledge and new technologies
Agency for Adult Education	May 25, 2006	Monitoring, development and evaluation of programs and institutions for adult education and lifelong learning
Education and Teacher Training Agency (former Institute for Education)	July 13, 2006	Teacher training and teacher licensing examinations Participation in development and implementation of national curriculum Monitoring of the development and implementation of the Croatian National Education Standard
II. Professional bodies		
National Bologna Follow-up Group	April 7, 2004	Follows up the development and implementation of Bologna process at the European level and Croatian higher education institutions Implements activities and project directed at promotion of Bologna process in Croatia
National Council for Information Society	September 2, 2004	Evaluates, establishes, and promotes priorities in the development of information society in the Republic of Croatia, especially implementation of priority measures and development goals
National Council for Higher Education†	December 3, 2004	Attends to the development and quality of entire higher education system in the Republic of Croatia
National Council for Science†	December 3, 2004	Attends to the development and quality of scientific activities and science system in the Republic of Croatia
Council for Science and Higher Education Funding	May 27, 2005	Advises the National Council for Science and National Council for Higher Education on financial matters Suggests criteria on allocation of budget for science and higher education Follows up, reports, and provides opinion on financial support to the science and higher education system
Committee for Ethics in Science and Higher Education	December 2, 2005	Promotes ethical principles and values in science and higher education, business relations, and public relations Follows up the application of modern technologies and environment protection in scientific research and higher education
III. Universities and Polytechnics		
Polytechnic of Knin	June 9, 2005	New institutions that were opened under the Government policy of polycentric development of the higher education system in accordance with regional needs and characteristic
Polytechnic of Vukovar	July 22, 2005	
Polytechnic of Gospić	July 6, 2006	
Polytechnic of Šibenik	July 6, 2006	
Polytechnic of Slavonski Brod	September 28, 2006	
University of Pula	October 3, 2006	

*Before Croatian Standards Institute and Croatian Accreditation Agency were established, these activities had been performed by the National Institute of Standards and Metrology, which became the National Metrology Institute after the Amendments to the Law on Organization and Scope of Activity of Central Public Administration Bodies had been passed (29).

†Activities and tasks of the listed professional bodies are described in detail in the Law on Scientific Activity and Higher Education (30).

tablished in Vukovar, Knin, Gospić, Šibenik, and Slavonski Brod, as well as the University in Pula (14).

Croatian National Education Standard

Croatian National Educational Standard (15) defines a comprehensive approach to education (13,15-25) and sets the guidelines for introducing national educational standards into the national curriculum. It incorporates educational goals, educational contents, proposed teaching methods, expected teaching outcomes, and desired classroom environment. As an open and dynamic approach, the Standard allows for continual improvement of the education system, making it responsive to the demands and needs of the economy and society. With that aim, in the primary education the scope of educational content is being reduced and emphasis put on creating basic and long-term knowledge, ensuring the basis for lifelong learning, and increasing the level of creativity and problem-solving capability. If high-quality teaching is to be achieved, teachers' creativity must be liberated and in-service teacher education intensified.

The MSES has taken steps to meet the major goals included in the Bologna declaration (28) – introducing Croatian National Educational Standard in schools and organizing lifelong learning system – which are to increase the international competitiveness of European higher education, create the European Higher Education Area, and enhance the employment rate and mobility of its citizens. This EU position is stated in the Berlin Communiqué by the following con-

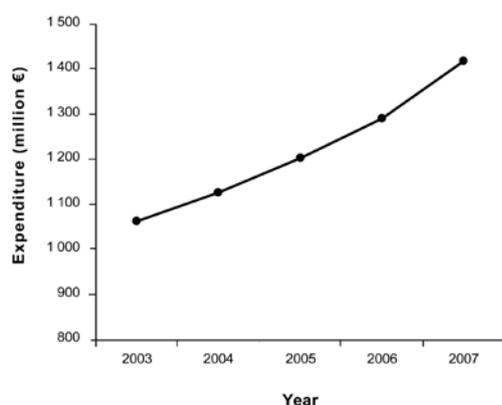


Figure 2. Increased investments in the development of science, technology, education, and sport in Croatia in the period 2003-2007 (32).

clusion of the ministers of EU member states, emphasizing the role of government in this process (31): “Ministers reaffirm their position that higher education is a public good and a public responsibility. They emphasize that in international academic cooperation and exchanges, academic values should prevail.”

Financial support

In line with the conclusions of the Berlin Communiqué (31), the Croatian Government has increased its investments in education and science system. In addition to providing for the professional needs of the existing highly qualified staff in these two sectors (Table 2), the Government has increased the MSES budget by 33.7% over the 2003-2007 period. Thus, in the last four years, the national budget allocated for education and science has increased by €360 million (Figure 2). Furthermore, the vision expressed in the documents of 2005-2010 Education Sector Development Plan and 2006-2010 Technology Policy of the Republic of Croatia has also been supported by the World Bank, which approved the loan of €67.8 million for education (33) and €31 million for science and technology (34). Such a beneficial financial situation in the sector will enable a cumulative increase in the salaries of teachers and scientists by 60% over the next 6 years,

Table 2. Human resources in Croatian education and science sector, October 2006

Degree	No. of researchers		total
	public institutes and universities	industry and private sector	
Master's	2568	3253	5821
PhD	5897	1064	6961
Other	2910*	10	2920
Total	11 375†	4327	15 702‡

*Including 1084 new research fellows since 2004.

†Including 1690 new job posts since 2004.

‡0.35% of the population of the Republic of Croatia.

which will be closely linked to the expected real increase in gross domestic product (14).

Besides providing for universities in Croatia, the Croatian Government has made a decision to invest around €49 million in the development of the University of Mostar, Bosnia and Herzegovina, the only university in the country where courses are held in Croatian language (35). Croatian Association of University Rectors, Science and Higher Education Funding Council, and National Council for Higher Education endorsed this decision. The increase in the number of students alone from 4500 in 1990 to 13000 in 2006 testifies to the development and importance of the University of Mostar (36).

Lifelong learning

Broad social changes, rapid transition into a knowledge-based society, aging of the population, and the pronounced need for continual modernization of the existing skills and knowledge and acquisition of new ones have prompted Europe to develop a new approach to education and learning – a concept of lifelong learning (9). Lifelong learning means continual improvement of knowledge, skills, and qualifications from the preschool to post-retirement age through formal, non-formal, and informal learning (Box 3). Accordingly, the MSES has started developing a system of adult education and preparing a national qualification framework to ensure international recognition of Croatian high school and higher education qualifications (13,37). Agency for Adult Education has been founded, which will deal with all activities related to adult education and lifelong learning. The Bill of Adult Educa-

tion is currently under consideration by the Parliament.

Accession negotiations with European Union

Croatia's accession negotiations with the EU began in the late October 2005, with the screening of the chapters on Science and Research (Chapter 25) and Education and Culture (Chapter 26). The screening process of these chapters was successfully completed on November 16, 2005 and negotiating positions adopted in March and April 2006. The negotiations on the Chapter 25 were completed at the meeting of EU ministers within a single day, June 12, 2006, because all the main questions had already been solved during the screening process (14). Furthermore, negotiations on Chapter 26 (Education and Culture) were completed (opened and closed) on December 11, 2006. European Commission concluded that Croatian policy on science, research and education is developing in the same direction as that of the European Union and that Croatia has enough scientific and research capacity to participate in EU programs (38,39).

One of the Lisbon strategic goals is to have investment in research and development increased to 3% of gross domestic product by 2010 (9). The Republic of Croatia is heading in the same direction. It has already increased the budget for science and technology and is planning to have two-thirds of the funding provided by the private sector (12,40). The level of expenditure on science will be regulated by the action plan on the proportion of gross domestic product spent on science and research (12). However, to increase the overall investments in science, especially by the private sector, it is necessary to strengthen the links between science, universities, industry, and society, ensure a stimulating legislative framework and favorable tax policies, and adjust activities of scientific institutions. A good example of cooperation between a Govern-

Box 3. Priority target groups for lifelong learning in Croatia (13):

- Adults without completed elementary or high school education
- Adults with completed high school education but not meeting the labor market needs
- Adults living in specific areas (eg, islands)
- Adults with special educational needs

ment-supported institution and private sector is the cooperation between Ruđer Bošković Institute and companies under the Institute’s ownership (Box 4).

<p>Box 4. Companies completely or partly owned by Ruđer Bošković Institute, Zagreb, Croatia:</p> <ul style="list-style-type: none"> • Ruđer-inovations (100%) • Chirallica Ltd (15%) • Biozyne Ltd (25%) • Information-communication technologies Ltd (15%)
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Science and technology

Croatia has a long tradition in science (14,41,42). Croatian science sector, which has experienced a steady growth over the recent years, is now undergoing major changes that will enable the achievement of the major goals set in the new Croatian strategy for development of science and technology in the 21st century. The new strategy is based on the Lisbon Declaration (9), the document “Croatia in the 21st century – Science” (43), and three official documents of the Republic of Croatia: Strategy for the Development of the Intellectual Property System of the Republic of Croatia for the 2005–2010 period (44); Development Strategy of Official Statistics of the Republic of Croatia for the 2004-2012 period (45); and Program of Statistical Activities of the Republic of Croatia for the 2004-2007 period (46) based on the Official Statistics Act (47). In October 2005, the National Council for Science adopted the decision on short-term and long-term priorities for the development of science in Croatia, based on the goals set in these documents (Table 3). Thereafter, the comprehensive vision of development of the science and research system, as well as the main goals of science and technology policy, has been laid out in the document “Science and Technology Policy of the Republic of Croatia 2006-2010” (12) (Box 5).

Based on the Croatian Science and Technology Policy (12), the World Bank has approved a €31 million loan for the development of innova-

Table 3. Short- and long-term research priorities in Croatian Science and Technology Policy (12) adopted by the National Science Council

<p>Priority research fields</p> <p>Short-term (2006-2008):</p> <ul style="list-style-type: none"> environment health energy and materials Croatian identity <p>Long-term (2006-2010):</p> <ul style="list-style-type: none"> knowledge-driven basic research environmental protection and economic development of the Karst regions, Adriatic coast, sea and islands agriculture, biotechnology, and food health information and communication technologies nanotechnology, new materials, construction, and new production processes energy, sources of alternative and renewable energy, transport, and security social and human sciences and Croatian identity social integration, learning and education, lifelong learning

tion and reorganization of the Institute of Naval Engineering, establishment of an agency for commercialization of science at Ruđer Bošković Institute, launch of the Unity Through Knowledge Fund program intended to motivate Croatian scientific diaspora to return and join the research projects in Croatia, and co-financing of Business Innovation Center of Croatia, BICRO Ltd (48).

<p>Box 5. Main goals of science and technology policy in Croatia (12):</p> <ul style="list-style-type: none"> • Increase funding for science and technology projects aiming toward 3% of gross domestic product for research and development (R&D), which will promote economic growth and job creation • Restructure publicly funded research institutes and R&D centers and reorient their activities toward national priority areas and industry needs • Encourage research partnerships and strengthen support programs for excellent young researchers, which will facilitate mobility, interdisciplinary and cross-sector cooperation, and build a more flexible research and education system • Invest in science research infrastructure and knowledge transfer institutions to further develop research capacity and provide access to business solutions • Introduce measures to promote commercialization of academic research so as to encourage universities and research institutions to work more closely and effectively with business • Introduce measures to promote technological development and innovation so as to attract people and investments into innovative business ventures • Administer stimulating and business-friendly legislation, including appropriate intellectual property laws and tax incentives for investment into priority R&D areas to build a system that encourages innovation

The Republic of Croatia also provided additional €5.7 million to support these projects (34).

Scientists in diaspora and their return to Croatia

The First Congress of Croatian Scientists from Croatia and Abroad, held in Zagreb and Vukovar in late 2004, gathered over a thousand Croatian scientists and prominent political, business, and social figures in Croatia (41,42). The event gave a strong impetus to the further development of science and technology in the Republic of Croatia. The Declaration on the conclusions of this meeting expresses the view that investing in people, education, and knowledge is the most valuable and effective form of investment (41,49). The Declaration was signed by the presidents of the Croatian Academy of Sciences and Arts and Croatian Association of University Rectors, Vice-Prime Minister of the Republic of Croatia, the Minister of MSES, and twelve scientists, two from each of the six different scientific areas, one living and working in Croatia and the other one abroad.

Establishing network of scientists

The idea of establishing a network and a database of Croatian scientists in Croatia and abroad to foster their cooperation and the idea of setting up an open-access database that would provide information on Croatian scientists, their work and activities, were both born at the Congress. Soon afterward, at the beginning of 2006, a web-service *Croatian Scientific Portal* (www.znanstvenici.hr) was established (Table 4) to facilitate interaction and cooperation among Croatian scientists (14,50), similarly to what has been done by the *Society For Public Understanding of Science – znanost.org* (53), informal society of Croatian scientists, teachers, and students in Croatia and abroad, via their *Connect* internet portal (54). Many successful and internationally recognized Croatian scientists work abroad and con-

Table 4. Basic services and initiatives of the *Croatian Science Portal* (<http://www.znanstvenici.hr>) (50-52)

Unit	Description
Croatian Scientific Bibliography (CROSBI)	Database of scientific and technical publications by Croatian scientists (over 144 000 records). Contains a library with full-text articles (over 2000 records). CROSBI project was launched in 1997, as all-inclusive database of publications resulting from scientific projects supported by the Ministry of Science, Education, and Sport.
Who Is Who in Croatian Science	Interactive interface for scientists to enter their own data and thus make them publicly available. Access and search of the database is open to public.
Croatian Journal Portal (HRČAK)	Includes all Croatian scientific and professional journals on open-access basis. The management system of this web-service helps editorial offices to post electronic versions of their journals.
Promotion of Open Access in Croatia	Promotion of open access in scientific and academic community in the Republic of Croatia. The basic goal is to achieve the establishment of institutional OA compliant repositories of published scientific and technical articles. Allowing free flow of scientific publication among scientists from different scientific disciplines via Internet is the basic purpose of such OA initiatives (Open Access/Archives Initiatives).

tribute not only to science as such, but also to the promotion of their homeland (55). Croatian American Society published five books on Croatian scientists from diaspora, *Distinguished Croatian Scientists in USA* (56,57) and *Distinguished Croatian Scientists in the World* (58-60), edited by Janko Herak. These books systematically present the work and activities of 44 world-renown Croatian scientists (Box 6).

Croatian Scientific Portal is only one of many web-services within the Croatian Scientists Network Project, a joint endeavor by the MSES, National Foundation for Science, Higher Education, and Technological Development of the Republic of Croatia, and the World Bank, with the purpose of connecting Croatian scientists in the country and abroad and thus creating conditions for their cooperation and, hopefully, encouraging the return of Croatian scientists from diaspora (50). In the last several years, many reputable scientists have returned to Croatia under the program of return of Croatian scientists (Table 5). Job positions for these scientists were secured by the MSES in cooperation with Croatian universities and scientific institutes. The Declaration of the First Congress of Croatian

Scientists from Croatia and Abroad (41,49) provided an extra impetus for the return.

Programs stimulating return of scientists

In 2005, the National Foundation for Science, Higher Education, and Technological Development launched the “Brain Gain” program intended to facilitate the return of scientists from

diaspora to Croatia. The program consists of four sub-programs as follows: Visitor, Senior, Postdoc, and Homing. The first three programs are open to all scientists, whereas the Homing program is intended to support successful Croatian scientists working abroad to establish a research infrastructure (€100 000 cap) in Croatia (61).

Table 5. Distinguished Croatian scientists who have returned to Croatia since 2004 at the initiative of the Ministry of Science, Education, and Sport (MSES), which ensured new job positions in cooperation with institutions

Name	Professional field	Institution of origin	Croatian institution	Year of return
Ivica Grković	biomedical sciences, basic sciences	The University of Melbourne, Melbourne, Australia	Faculty of Medicine, University of Split	2004
David Smith	natural sciences, chemistry	University of Sydney, Sydney, Australia	Ruđer Bošković Institute, Zagreb	2004
Zoran Škoda	natural sciences, mathematics	Department of Mathematic, Indiana University, Bloomington, (IN), USA	Ruđer Bošković Institute, Zagreb	2004
Helena Tomas	humanities, archeology	University of Oxford, Oxford, United Kingdom	Faculty of Philosophy, University of Zagreb	2004
Saša Zelenika	technical sciences, mechanical engineering	Paul Scherrer Institute, Villigen, Switzerland	Faculty of Engineering, University of Rijeka	2004
Damir Čavar	humanities	Indiana University, Bloomington (IN), USA	Department of English Language and Literature, Faculty of Philosophy, University of Zadar	2005
Renata Kobetić	natural sciences, chemistry	Rutgers University, New Orleans, (LA), USA	Ruđer Bošković Institute, Zagreb	2005
Milan Sak-Bosnar	natural sciences, analytical chemistry	University of Applied Science, Waedenswill, Switzerland	Faculty of Food Technology and Technology, University of Osijek	2005
Frano Barbir	technical sciences, mechanical engineering	University of Connecticut, Storrs, (CT), USA	Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split	2006
Vedran Deletis	biomedical sciences, clinical medicine	St. Luke's Roosevelt Hospital, New York, (NY); USA	Faculty of Medicine, University of Split	2006*
Vladan Desnica	natural sciences, physics	Institute of Science and Technology in Art, Academy of Fine Arts in Vienna, Austria	Scholar of National Foundation for Science, some projects on Ruđer Bošković Institute	2006
Mathieu Dotour Sikirić	natural sciences, mathematics	Hebrew University, Jerusalem, Israel	Ruđer Bošković Institute, Zagreb	2006
Mario Grčević	humanities, philology	University of Mannheim, Mannheim, Germany	Department for Research in Linguistics, Croatian Academy of Arts and Sciences	2006
Željko Jeričević	natural sciences, chemistry	Baylor College of Medicine, Houston, TX, USA	Faculty of Medicine, University of Rijeka	2006
Karlo Koch	biomedical sciences, molecular biology	Bowling Green State University, Ohio, (OH), USA	Ruđer Bošković Institute, Zagreb	2006
Ivan Kolovrat	technical sciences, design and communication	University of Applied Sciences, Wiesbaden, Germany	Arts Academy, University of Split	2006
Ivica Kopriva	technical sciences, electrotechnics	The George Washington University, Washington DC, (NW), USA	Ruđer Bošković Institute, Zagreb	2006
Dario Krešić	technical sciences, computers and networks	Technische Universität München, Munich, Germany	University of Dubrovnik	2006
Biserka Mulac Jeričević	natural sciences, chemistry	Baylor College of Medicine, Houston, TX, USA	Faculty of Medicine, University of Rijeka	2006
Mladen Petračić	natural sciences, analytical chemistry	Australian National University, Canberra, Australia	Department of Physics, Faculty of Philosophy, University of Rijeka	2006
Zlatko Pleše	humanities	University of North Carolina, Chapel Hill, NC, USA	Croatian Studies, University of Zagreb	2006*
Ivan Poljaković	humanities	University of Auckland, Auckland, New Zealand	Department of English Language and Literature, Department of German Language and Literature, Faculty of Philosophy, University of Zadar	2006
Viktor Sučić	technical sciences, electrotechnics	Queensland University of Technology, Brisbane, Australia	Faculty of Engineering, University of Rijeka	2006
Boris Škvorc	humanities, philology	University Macquarie, Sydney, Australia	University of Split	2006
Caroline Hornstein-Tomic	cultural anthropology, sociology	Goethe Institute, Frankfurt/Main, Germany	Ivo Pilar Institute for Sociological Research, Zagreb	2006*

*About to be employed.

Box 6. Croatian scientists whose biographies were included in 5 books published by the Croatian-American Society in cooperation with Croatian Heritage Foundation, 1997-2005 (56-60):

Croatian scientist (country)	Author of presentation
Distinguished Croatian Scientists in USA (part 1)	
Milan Randić	Nenad Trinajstić, Sonja Nikolić
Egon Matijević	Nikola Kallay, Jasenka Bišćan
Petar Alaupović	Janko Herak
Branko Leskovar	Hrvoje Babić
Vladimir Katović	Marijan Pribanić
William Feller	Hrvoje Šikić, Sibe Mardešić
Luka Milas	Vlatko Silobrčić
Distinguished Croatian Scientists in USA (part 2)	
Milislav Demerec	Draško Šerman, Maja Vlahović, Ljiljana Šerman
Stjepan Kukolja	Miće Kovačević
Dragan Miličić	Mirko Primc, Marko Tadić
Stjepan Poljak	Miloš Judaš
Krsto Prelec	Ksenofont Ilakovac
Tefko Saračević	Tanja Aparac
Eduard Prugovečki	Mladen Martinis
Zvonko Vranešić (Canada)	Leo Budin
Sanjo Zlobec (Canada)	Luka Neralić
Franjo (Francisco) Krmpotić (Argentina)	Dubravko Tadić
Distinguished Croatian Scientists in the World (part 1)	
Zvonimir Janko (Germany)	Juraj Šiftar
Stjepan (Estaban) Horvat (Argentina)	Miljenko Lapaine
Vladimir Glaser (Switzerland)	Nikola Zovko
Stjepan Marčelja (Australia)	Janko Herak
Jasna Peter-Katalinić (Germany)	Mirna Flögel
Danko Gajski (USA)	Alex Orailoglu
Miroslav Radman (France)	Zoran Zgaga
Davor Solter (Germany)	Draško Šerman, Floriana Bulić-Jakuš, Maja Vlahović, Ljiljana Šerman
Ivan Damjanov (USA)	Mara Dominis
Distinguished Croatian Scientists in the World (part 2)	
Ivo Derado (Germany)	Nikola Zovko
Zlatka Grubišić-Gallot (France)	Zorica Vekslj
Mirko Dikšić (Canada)	Dorothea Mück-Šeler, Nela Pivac
Andrija Kornhauser (USA)	Jelka Tomašić
Vladimir Hlady (USA)	Nikola Kallay
Nebojša Avdalović (USA)	Zvonimir Kaić
Suad Efendić	Mladen Vranić
Mladen Vranić (Canada)	Richard Bergman
Distinguished Croatian Scientists in the World (part 3)	
Krešimir Krnjević (Canada)	Jack Diamond
Mirjana Randić (USA)	Vjekoslav Miletić
Stevo Julius (USA)	Duško Kuzmanić
Hedvig Hricak (USA)	Miljenko Marotti
Stanimir Vuk-Pavlović (USA)	Janko Herak
Predrag Cvitanović (USA)	Vladimir Paar
Branko Ladanyi (Canada)	Ratimir Mocnaj
Nikola Tesla (USA)	Janko Herak
Leopold Ružička (Switzerland)	Sonja Nikolić, Nenad Trinajstić
Vladimir Prelog (Switzerland)	Miljenko Dumić

Table 6. Written consent of the project leader to ensure responsible conduct of research and scientific integrity is part of the research project or program application form included in the 2006 project application process*

For distribution of research funds, the Ministry of Science, Education, and Sports will take into consideration only those research project applications that conform to the highest international standards of scientific integrity and personal and institutional responsibility in conduct of research and comply with positive regulations of the Republic of Croatia.

Director of institution and project leader guarantee the implementation and conformity of the research with the stated above in accordance with the Agreement for Work on Research Project reached with the Ministry of Science, Education and Sports, as well as the project leader by signing both the Research Project Application Form and the document on Consent of Project Leader

Only research that meets all the listed criteria of scientific integrity, collegiality, protection of human subjects, protection and care of research animals, integrity toward institution, and social responsibility is considered responsibly conducted research.

1) Scientific integrity

- a) All researchers on the project are competent in the field of research, as validly substantiated by relevant evidence (references and *curriculum vitae*) whose authenticity and validity is guaranteed by the signature of the project leader
- b) The right to research results, intellectual, proprietary and other rights to the amount or to the relative proportion in which the Ministry funds or participates in funding the research project shall be regulated by the Agreement for Work on Research Project
- a) Analysis of the data resulting from the project is correct and in accordance with scientific methodology. Statistical analysis of data are performed exclusively by the use of appropriate and most strict criteria and testing
- b) Research results in whatever form presented consistently correspond to the research conducted and there is no fabrication, correction or plagiarizing of data, results, ideas, procedures or words in the procedures of proposing, conducting, revising or presenting the research. Research idea and aim stated in the project application are the original work and do not contain in whole or in any part unauthorized appropriation of another person's ideas, data, results or words
- c) Only original copyright work in direct connection with the research shall be considered a research report resulting from the research/project, which excludes any form of scientific misconduct, such as auto-plagiarizing and duplicate publications

2) Collegiality

- a) Authors and co-authors of all research reports and published work resulting from the research/project fulfill the following criteria: (a) development of research idea and substantial contribution to the concept and design of the research; (b) data collection, data analysis, or interpretation of research results; and (c) writing and designing a research report and published work or providing critical revision and final approval of the research report and published work. Author should fulfill at least one condition from each (a), (b), or (c) category.
- b) Exchange of information is free, as is use of equipment which is publicly funded
- c) Mentor relationships arising from the research/project and respective obligations of the mentors and mentorees rest on mutual respect and agreement on intellectual ownership of results, procedures, patents, and similar

3) Protection of human subjects

Every research/project is approved by a relevant body – institutional ethics committees or similar – where adherence to all relevant international and local laws, regulations, and directives on protection of human subjects is required. In addition to the approvals from competent ethics committees, signed and sealed by the institution and compulsorily attached to a printed copy of the research application, by this Consent the project leader on the project/research guarantees as follows:

- a) voluntary participation of all human subjects
- b) informed consent from human subjects
- c) confidentiality, secrecy, and anonymity of information on human subjects
- d) cost/benefit ratio favorable to human subjects

4) Protection/Care of Research Animals

If experimental animals are used in the research/project, the project leader guarantees the strict abidance to the Animal Welfare Act (Narodne novine, No. 19/99) and explicitly describes and confirms the abidance to the Act along with all relevant documentation on procedures, protocols, institution, animal enclosures, manner, and competency in keeping live experimental animals and certificates of competent institutions (ethics committees, authorized veterinarian, and similar).

5) Integrity in relation to institution

By signing this Consent, the project leaders guarantees as follows:

- a) absence of financial or proprietary conflict of interest and absence of conflict of interest in relation to the parent institution
- b) absence of conflict of loyalty/commitment to parent institution while conducting the research/project, absence of research conducted for private or public institution the scope of which is broader than the scope of regular work or completely prevents the project leader from performing regular work;
- c) familiarity with rules/directions/statutes of the institution proposed as the research site.

6) Social Responsibility

By signing this Consent, the project leader assumes the social responsibility and:

- a) proposes research projects of social importance/priority
- b) guarantees adherence to the highest ecological norms and provides a detailed description of environmental (and social) impact and treatment of toxic and other waste produced during research
- c) guarantees that all procedures and materials used in the research/project are pursuant to the positive regulations of the Republic of Croatia.

I¹, (First name, Last name of the project leader), the project leader understand all instructions, obligations, and responsibilities relating to public funding of the proposed research project and hereby oblige myself to conduct the proposed research/project adhering to the highest professional standards of which only some are stated above as well as to all positive legislation, rules, and regulations relating to the area and field and subjects/objects of the stated research.

By signing this agreement I confirm that I have read, understood, and accepted everything stated above and that the proposed research/project is in accordance with the obligations, duties, and responsibilities stated, for which I accept full moral, material, and criminal liability.

(Signature of the project leader)

*Prepared according to international documents and regulations (66-70) by Vedran Katavić from the Zagreb University School of Medicine, Lidija Bilić-Zulle from the Rijeka University School of Medicine, and Mladen Petrovečki from the Ministry of Science, Education and Sports (MSES), approved by the National Council for Science.

Box 7. Activities of the Unity Through Knowledge Fund (62):

- Motivating Croatian scientific diaspora to do research in Croatia. The Fund covers expenses of moving, purchasing specific laboratory equipment, scholarships, and financial awards. Scientific institutions in the Republic of Croatia host award winners and ensure the needed research infrastructure in the areas of high priority for economic growth of Croatia. Award winners might obtain temporary functions and have the possibility to develop research institutes.
- Establishing network of Croatian scientific diaspora. The Ministry of Science, Education, and Sports and Croatian Academy Research Network (CARNet) would jointly launch the development of network run by a special team to facilitate communication among Croatian scientists in the world.
- Short-term visits to Croatia of distinguished Croatian scientists working abroad, including their short-term engagements in Croatian research institutions and industry and joint appointment of Croatian scientific diaspora at Croatian scientific institutions.
- Stimulating Croatian scientific diaspora to found companies in Croatia through special incentives, such as tax deductions, reduced taxation on their products, and availability of new commercial real estates at favorable prices.

Within the framework of scientific and technologic development supported by the loan from the World Bank, MSES has also launched the Unity Through Knowledge Fund program (62). The mission of the Fund (Box 7) will be realized through the projects stimulating cooperation with diaspora, the overall goal being to incite knowledge-based economic changes.

Scientific research and research projects

In January 2006, new criteria for the selection of research projects and programs for MSES support were introduced. These new selection criteria are in line with the EU standards, but also respect the priorities set in the Croatian science development plan (Table 3) (12), conform to the priority areas defined in the 6th Framework Program of the European Union (63) and criteria of excellence, as well as take into account the specific characteristics of different research areas (14). The main novelty, introduced to allow the selection of research projects according to the international criteria of excellence, is the involvement

of international reviewers, particularly from Austria, Slovenia, Israel, Hungary, Ireland, and USA, in the peer review of research projects (14). The new criteria also stimulate combining individual projects in the same research area into programs and encourage institutional, national, and international cooperation, including scientists from diaspora and foreign scientists. Another novelty is the electronic application and review of the projects via a newly established computer system. Information on the outcome of the review process and the MSES final decision on the projects is available at the MSES webpages (64).

The changes in the project application process also include the introduction of internationally accepted principles of research integrity (65) to which the applicants subscribe during the process of project application by signing the Agreement on Responsible Conduct of Research and Scientific Integrity (Table 6).

An important aspect of the MSES support is the system of research fellows, mostly young scientists employed at universities and public institutes immediately after graduation. Since 2004, the MSES has approved 1084 new research fellow positions (71) and today supports around 2500 young scientists (Table 2).

On January 1, 2006, Croatia became a full member of the European 6th Framework Program for Research and Technological Development, which provides the main framework for activities in the field of science, research, and innovation at the European level. Previously, Croatia did participate as a third country in this program ever since it had been launched in 2002, but due to a third-country status it had a limited access to applications (14,72).

According to the European Commission data, Croatia had signed 60 contracts co-financed by the European Commission (€5.8 million) by February 1, 2006. For the full participation of Croatia in the program, a total of €6.4 million were allocated – €3.18 million from the state budget and the rest from the PHARE-program

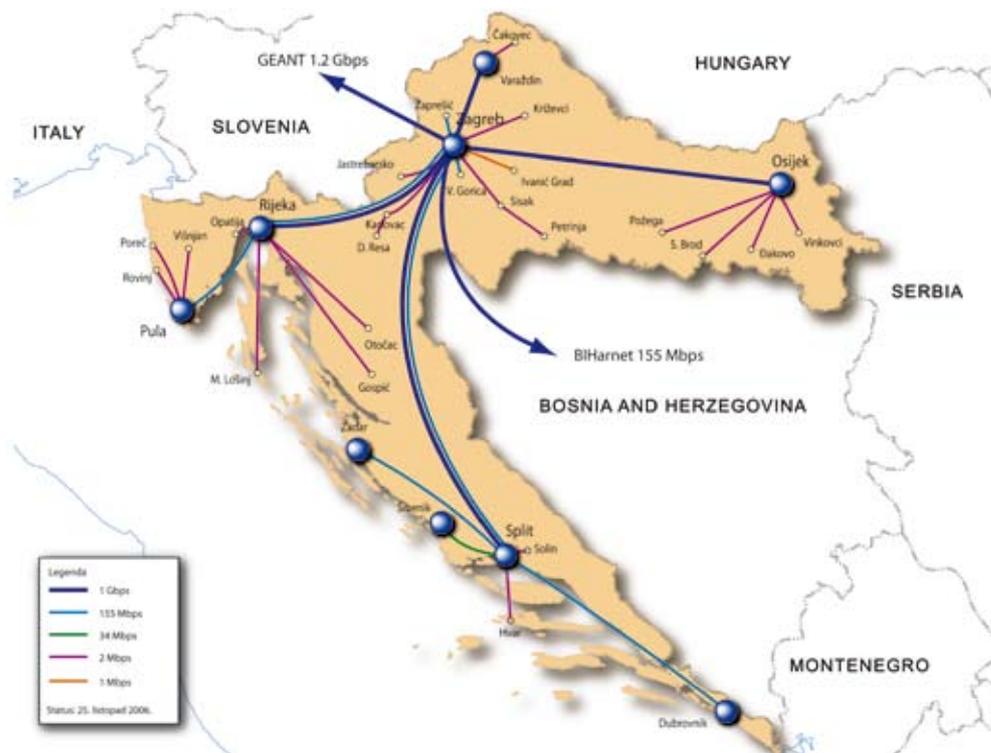


Figure 3. Croatian Academic Research Network (CARNet) communication infrastructure in the Republic of Croatia (status on October, 2006). CARNet is the government body, within the system of science, higher education, and technology. CARNet network/web is used by researchers, professors, students, and administrative staff of the scientific and educational institutions. CARNet web links all major Croatian cities at several levels of different technologies and access speed. The axis of CARNet web links all university centers (Dubrovnik, Osijek, Pula, Rijeka, Split, Zadar, and Zagreb) by high-speed links (ranging from 155 Mbit/s to 1 Gbit/s), whereas smaller centers are linked by modem links with 1-2 Mbit/s speed (74).

budget for the Republic of Croatia (14). It is apparent that all our investments have so far been recouped. Since 60 contracts had been signed for projects applied for in 2005, before the official status of Croatia in FP6 changed, the total number of contracts is now expected to amount to 85-90, and the total amount received from the European Commission for these projects is expected to be €7 million by the end of 2006. The 7th Framework Program will be open from 2007 to 2013 (73).

Information society

All elementary schools, high schools, higher education institutions, research institutions, and student campus dormitories are connected to Croatian Academic Research Network (CARNet). The network has a gigabit infrastructure and all users have free Internet access (Figure 3) (74).

Because of the introduction of information system into higher education institutions, it is possible to have Internet-based education, technical support, application and cancellation of exams, organization of teaching timetable, and information on exam terms and students status all available online (75). The Support Center has been established at the University Computing Center in Zagreb, and the system implementation contract has been signed with 68 of 106 public higher education institutions. The system has been introduced in 35 higher education institutions, encompassing 45% of students in the Republic of Croatia (14). In 2002, the project of setting up computer networks and connecting student campus dormitories to the internet was started. In the first three phases, 80% of student dormitories were connected (14), and by the end of 2006, the dorm networks will be established in all remaining student campuses in Croatia. Fur-

thermore, 600 000 e-mail addresses have been ensured for all students in Croatia and 1200 schools got a computer room equipped with 15 computers and a server (14). Several thousand teachers received European Computer Driving License. Learning Management System, established in December 2005, has enabled distance learning (especially on islands), "smart-boards" are being installed in the classrooms, and application of e-content is under way (first for teaching mathematics and physics) as well as additional didactic components.

Where from here?

The main goals of Science and Technology Policy are increased investment in science, research, and development based on the principles of excellence and support of all measures leading to the development of technology and innovations, such as strengthening connections between science and industry. The priorities also include fostering international scientific cooperation and participation in the European Framework Programs as well as ensuring support for outstanding young researchers.

The changes in the education system are in line with the goal of creating a knowledge-based society and target every level and aspect of school education, including lifelong learning. Croatian National Educational Standard is being introduced into elementary schools and compulsory education is extended to high school education. High school graduation examination has become mandatory. Bologna process is carried out at the higher education level, close links between science and education are promoted, and support is provided for the development of scientific institutions. These coordinated efforts are expected to contribute to the Croatian goal to become the most competitive science- and education-based society in this part of Europe by 2010 – "a small country with great knowledge."

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