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Science and Technology Country Report

CROATIA

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1 Introduction

This country report is produced by the “Information Office of the Steering Platform on Research for Western Balkan Countries” and reviews the situation of Science and Technology (S&T) in Croatia.

The report summarises the main papers published by the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the South-East European ERA-NET (SEE-ERA.NET), the Austrian “Gesellschaft zur Förderung der Forschung”, and several independent scholars on the issue of S&T in Croatia. For the complete table of references please see References in chapter 7, starting on page 134 of this report.

The objective of this study is to enhance our understanding of the national innovation system in Croatia. An overview of the situation in S&T regarding the main stakeholders, input and output indicators, the national strategies and priorities and the main documents and laws in the field is given below.

The ‘system of innovation’ approach was taken into account when compiling this report, and covers important factors influencing the development, diffusion and the use of innovations, as well as the relations between these factors. It does not place emphasis on individual firms or research organisations, but rather on innovation as an interactive and interdependent process.

Relevant organisations in this respect are firms, higher education institutions, government agencies, etc. interacting to create knowledge and innovation. The macro-level of the system is analysed using indicators such as R&D personnel ratios, R&D expenditure, patent application intensity rates, etc.

The report was compiled in autumn 2006 by the Information Office, by Ms. Elke Dall and Ms. Maruška Bračić, Centre for Social Innovation, Vienna, Austria and reviewed by Mr. Miroslav Polzer, Centre for Social Innovation / Austrian Science and Research Liaison Office Ljubljana, Ms. Emira Bečić, Ministry of Science, Education and Sports, Croatia and Ms. Jadranka Švarc, Institute of Social Sciences Ivo Pilar Zagreb. A brief update was carried out in summer 2007 by Mr. Jure Zrilič, Centre for Social Innovation. A final review was carried out in December 2007/January 2008.

1.1 Croatia - A Brief Profile

Before the dissolution of the SFRY (Socialist Federal Republic of Yugoslavia), Croatia was (after Slovenia) the most prosperous and industrialised region in the country. The economy emerged from a mild recession in 2000 with tourism, banking and public investments leading the way. Although the macroeconomic situation has largely been stabilised, structural reforms have not been as successful.

Today, Croatia is a presidential, multi-party parliamentary democracy with a population of 4.4 million and a GDP of EUR 34,220 billion in 2006 or EUR 7,706 per capita (Becic and Svarc, 2007). In 2006, the annual average real growth was 4.8 %. In the first quarter of 2007, real GDP growth accelerated markedly to 7 % year on year, up from 6% in the same quarter of the previous year. Unemployment rates in Croatia have been in decline (12.7% in 2005 and 11.2% in 2006), but a small increase in unemployment is predicted for 2007 and 2008 (European Commission, 2007).

Administratively, the country is divided into 20 counties (županije), in addition to the city district of the capital, Zagreb. The Croatian population represents about 0.96 % of that of the European Union (EU), while its economy in 2005 was about 0.28 % of the EU's economy, in terms of gross domestic product (GDP). The European Union's official stance is that the country is a functioning and stable democracy. Following the launch of accession negotiations, Croatia needs to focus on the substantial tasks ahead in terms of adopting EU legislation and building the administrative structures and capacity necessary for its correct enforcement (European Commission, 2006; Becic and Svarc, 2007).

Croatia has undergone a difficult de-industrialisation process since gaining its independence. The importance of industry, including the energy sector, declined to some 20.5% of total GDP in 2006, while the service sector represented about 67.4% of total GDP. The share of agriculture, hunting and fishing has slowly declined during the last few years and now represents 6.2% of total GDP in 2006. Overall, Croatia is an open economy and its main trading partners are from the EU (accounting for over 50% of all imports and exports) – its most prominent partners being Italy, Germany and Austria, while Croatia itself also represents the EU's main trading partner in the Western Balkans region. Moreover, since the opening of the EU market under the Autonomous Trade Measures in 2000 and the trade provisions of the Stabilisation and Association Agreement in 2002, trade between the European Union and Croatia doubled between 2000 and 2004. In 2005, the European Commission concluded that Croatia is a functioning market economy able to cope with competitive pressure and market forces within the EU, provided that it continues to implement its reform programme to improve the remaining weaknesses. There is, however, a potential risk to Croatia's macroeconomic stability due to certain external and fiscal imbalances. Furthermore, administrative and judicial barriers need to be removed in order to allow the development of a more prominent private sector and to encourage foreign direct investment. In addition, state interventions in the economy remain significant and little progress has been made with regards to large state-owned enterprises, thus the strengthening of financial discipline within state-owned enterprises remains a particular economic policy challenge. It is clear that Croatia will need to address the identified weakness with much will and determination (European Commission, 2006; Becic and Svarc, 2007).

1.2 Relations between Croatia and the EU

Croatia was the second country to sign a Stabilisation and Association Agreement (SAA) with the EU in October 2001, an agreement which entered into force in February 2005. The SAA is an essential instrument for the EU's Stabilisation and Association Process with the Western Balkans, providing a contractual framework for relations between the EU and Croatia, until Croatia's final accession to the EU. Full implementation of the SAA will aid Croatia in its preparation for EU membership, while the progress and dynamics of the integration process will depend upon Croatia's fulfilment of its SAA commitments. The European Commission will help Croatia in the implementation of the agreement by providing technical advice and financial assistance (European Commission, 2006).

Croatia presented its application for EU membership in February 2003. The Commission published its response to the application in April 2004, maintaining that Croatia is both a functioning democracy and a functioning market economy, which should not face major difficulties in complying with the objectives of the *acquis*, providing it continues in its efforts to make the necessary adjustments. Following the positive assessment by the Commission, the European Council of 17th-18th June 2004 decided that Croatia should receive candidate country status. However, there was still one important pending issue between the EU and Croatia that needed to be resolved before the country could actually start the negotiation

process - full cooperation with the ICTY (UN International Criminal Tribunal for the former Yugoslavia). A positive review of such cooperation arrived on 3rd October 2005, allowing the Council to open negotiations with Croatia that same day. The first stage of negotiations - the so called "screening" - enables the EU to decide when to open individual chapters for negotiations. The first field to face scrutiny after the negotiations were officially opened was cooperation in Science and Research (Chapter 25), which opened and (temporarily) closed on 13th June 2006. The draft screening reports have been transmitted to the Council for discussion within the Member States. The degree of convergence between the national policy of Croatia and the European Research Area was satisfying and no major difficulties in accepting the EU *acquis* on research are expected. Overall assessment of the current situation in the field of science and research was very good: Croatia has expressed determination to further increase the level of financing of the sector and to fulfil all remaining prerequisites for cooperation with the European Framework Programmes for S&R. A milestone in this respect was Croatia's accession as a fully associated country to the Sixth Framework Programme (FP6) for the remainder of 2006. In 2007 Croatia gained the "associated status" in FP7 as well. The next chapter scheduled in the negotiation process for Croatia was Education and Culture (Government of the Republic of Croatia, 2006b). Negotiations on this Chapter 26 (Education and Culture) were completed on 11th December 2006. The 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 programmes (Petrovecki, Paar et al., 2006).

As a candidate country, Croatia benefited from all three pre-accession financial instruments - PHARE (Poland and Hungary: Assistance for Restructuring their Economies - the funding programme which has expanded to cover ten countries), ISPA (Instrument for Structural Policies for Pre-Accession) and SAPARD (Special Accession Programme for Agriculture and Rural Development). Croatia was also eligible for the CARDS Regional Programme in 2005 and 2006. Pre-accession financing was estimated at EUR 105 million in 2005 and EUR 140 million in 2006, which represents a substantial increase in overall EC assistance compared to the amounts pledged by CARDS (EUR 60 million and EUR 62 million in 2005 and 2006 respectively). An overall total of EUR 262 million was allocated to Croatia from the CARDS programme between 2001 and 2004 (European Commission, 2006). From 1st January 2007, the Commission uses a new financial tool, the Instrument of Pre-Accession (IPA), for promoting modernisation, reform and alignment with the *acquis*. IPA has entirely replaced CARDS and other pre-accession financial instruments (PHARE, ISPA, SAPARD). The programming has five components - Transition Assistance and Institution Building; Regional and Cross-Border Cooperation; Regional Development; Human Resource Development and Rural Development. As a region, the Western Balkan countries and Turkey will benefit from almost EUR 11.5 billion of pre-accession financial instrument money between 2007 and 2013.

Under the objectives laid out in the Negotiating Framework, the negotiations are based on Croatia's own merits and the pace depends on the country's progress in meeting the membership requirements. Although the shared objective of the negotiations is accession, the very nature of discussions implies an open-ended process whose outcome cannot be guaranteed beforehand (European Commission, 2005b). The European Council laid out the principles, priorities and conditions for all principal areas regarding the Accession Partnership with Croatia in its decision of 20th February 2006. A distinction was made in terms of defining short-term and medium-term priorities, the former to be accomplished within one to two years and the latter within three to four years. Science, research and education were placed amongst medium-term priorities, advising the country to start designing and applying an integrated research policy, to step-up its efforts for creating a modern vocational education and training system and to ensure the implementation of the Bologna criteria for higher

education (European Council, 2006).

The 2006 “National Programme for the Integration of the Republic of Croatia into the European Union”, which is the fourth annual national programme for the implementation of the SAA, has also laid out ongoing and upcoming activities for the Ministry for Science, Education and Sports regarding the creation of required capacities in the field of RTD (Government of the Republic of Croatia, 2006c). Implementation capacity refers to the conditions necessary for effective participation in the Framework Programmes, thus in the field of RTD, Croatia needs to create certain implementation capacity, including an increase of personnel for the activities of the Framework Programmes. Due to its specificity, the *acquis communautaire* in the field of science and research does not require any transposition in the national legal order (European Commission, 2004).

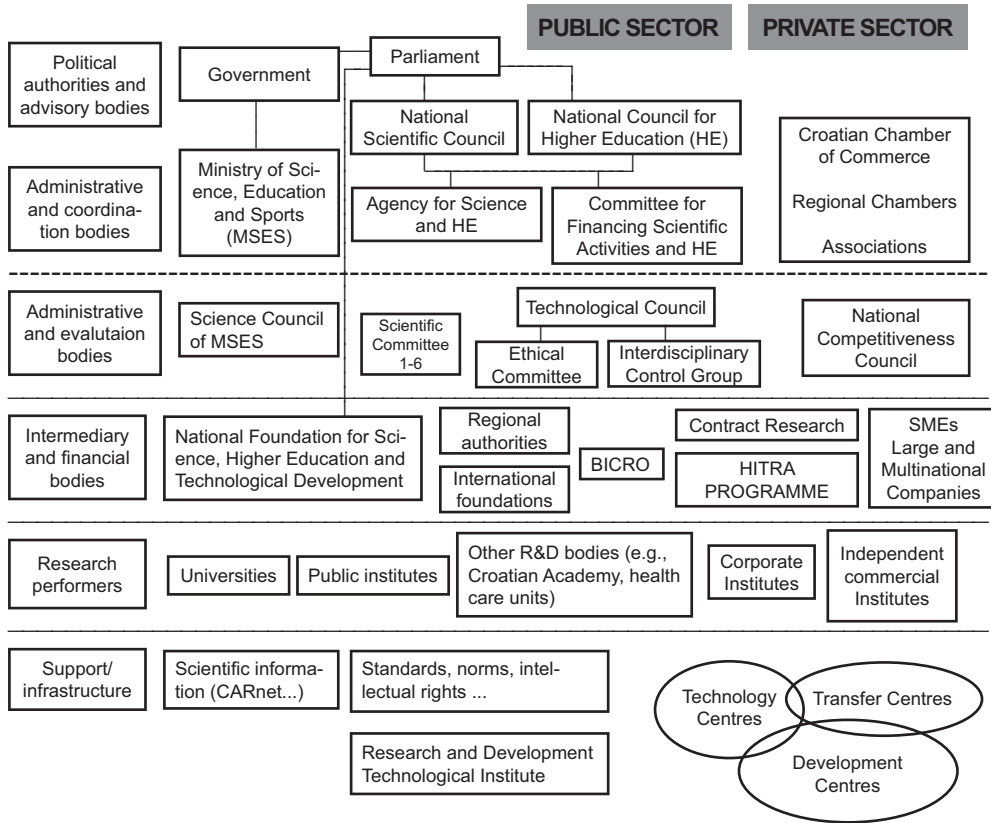
It is rather difficult to predict the possible accession date for Croatia, bearing in mind the internal issues within the European Union that need to be resolved before accommodating any new members after 2007 (under the Treaty of Nice, the EU can function with no more than 27 member states). This problem would have been solved with the approval of the EU Constitution in all 27 EU member states, but its rejection has made any future accession more difficult, requiring additional administrative reforms. Nevertheless, the closure of negotiations for all 35 chapters of the *acquis communautaire* is expected in 2008 or 2009.

A new EU treaty, which has been suggested to be drafted by 2009, should erase all legal blocks currently preventing accession by Croatia to the Union. With the entry into force of that treaty - probably May 2009 - Croatia will be able to join the European Union. On 25th April 2007 the European Parliament congratulated Croatia for making “rapid progress” towards membership, but stated that “it must make further efforts in areas such as cooperation with the ICTY, reform of the judiciary and the transition to a market economy”. The need for a new institutional framework for the EU by 2008 in order to accommodate Croatia was also stressed (EurActiv, 2006a).

2 Contemporary Institutional Landscape

After experiencing typical transitional problems in the field of S&T, Croatian official policy has started to pay this field more attention since the year 2000. The infrastructural system for promoting RTD (research and technological development) in Croatia has been enhanced with a variety of new institutions. Institutional measures for the formation and strengthening of the national system are ongoing and will also continue in the future (Dall, 2006).

Figure 2.1: Institutional Set-up for R&D in Croatia (Becic and Svarc, 2006)



2.1 Main Stakeholders Involved in Policy Making in Croatia

Over the last few years, measures have been implemented to create new institutional capacities in the Croatian innovation system and to strengthen the existing ones. Numerous initiatives have been promoted and it is almost impossible to track The national network of institutions engaged in the development, transfer, application and financing of new technologies and innovative entrepreneurship is constantly being updated and enlarged (Dall, 2006).

By the end of 2006, the infrastructure of the S&T stakeholders in Croatia included 26 public research institutes, five technological centres, one business and innovation centre, seven research institutes in industry and six private scientific institutes. The Croatian higher education system comprises seven universities (including 81 faculties, academies and other accredited constituent parts offering programs of study), 16 public colleges and polytechnics and 16 accredited private schools and polytechnics (Government of the Republic of Croatia, 2006d; Becic and Svarc, 2007). Furthermore, there are about 50 legal scientific research entities (in business, cultural, health and state institutions), the Interuniversity Centre in Dubrovnik (an association of about 200 Croatian and foreign universities), the Croatian Academy of Sciences and Arts, the Medical Academy, the Academy of Technical Sciences, the National and University Libraries, and the Croatian Academic and Research Network (CARNet) - a large network of Croatian academic and research institutions (European Commission, 2004).

Science and research in Croatia are under the authority of the Ministry of Science, Education and Sport (MSES). Administration and other tasks related to R&D are carried out by the following Ministry units: The Science Directorate, The Directorate for Higher Education, The Directorate for Information Society, and The Directorate for International Cooperation.

The National Science Council and the National Council for Higher Education are advisory bodies which formulate and monitor the functioning of R&D programmes and higher education organisations. The National Science Council attends to the development and quality of scientific activities and science system in the Republic of Croatia, while the National Council for Higher Education attends to the development and quality of the entire higher education system in the Republic of Croatia (Petrovecki, Paar et al., 2006). The National Science Council appoints Scientific Field Councils for Natural, Technical, Biomedical, Bio-technical and Social Science, Humanities and Art. The MSES carries out administrative activities along with other tasks concerning the development of scientific research, scientific-technical information and communication. For example, the ministry works for the foundation and development of science and the application of scientific achievements, it harmonises the financing programmes for permanent research activity, contracted projects and scientific projects of special interest, as well as planning, harmonising and developing IT activity and its integration into the overall information system in the Republic of Croatia. In addition, the MSES monitors, documents and implements scientific, technical and technological cooperation with foreign countries and international organisations according to international agreements, it sends Croatian experts abroad and helps to integrate foreign experts with activities in the Republic of Croatia. The Ministry prepares draft laws and ordinance in the areas of science, research, technology, education and sport to be submitted to the Croatian Parliament by the Government of the Republic of Croatia. The MSES also manages the budgetary funds for these areas (European Commission, 2004). There is also a Council for Science and Higher Education Funding, which advises the National Council for Science and National Council for Higher Education on financial matters (Petrovecki, Paar et al., 2006).

In July 2004, the government established the Agency for Science and Higher Education which carries out administrative tasks related to the evaluation of scientific activity, scientific projects, collaborative scientific programmes and higher education. It also carries out tasks related to the National Network for Quality Assurance of Higher Education and its integration into the European Quality Assurance Network. The agency is a state institution with autonomous powers to carry out the aforementioned tasks for the National Science Council and the National Council for Higher Education, thus complying with the European standards in science and higher education. The act envisages the National Science Council as a strategic body responsible for the development and quality of overall scientific activity in Croatia. Its major functions are to evaluate scientific organisations, to determine scientific disciplines and interdisciplinary fields of science and arts, to set detailed requirements for attaining authority to conduct a procedure for appointment into science ranks, evaluation of scientific projects, collaborative scientific programs etc. The National Science Council shares the task of submitting proposals to the Croatian government on the allocation of budgetary financial resources for scientific activity and higher education with the National Council for Higher Education.

The Technology Council of the MSES focuses on the establishment of a national network of institutions engaged in the development, transfer, application and financing of new technologies. It also works to gain specific measures of governmental support for technological development and innovative entrepreneurship.

Regarding industrial R&D and innovation, the Business and Innovation Centre of Croatia

(BICRO) is of central importance - it focuses on financing technology development programmes, such as RAZUM (which supports the development of knowledge - and new technology-based enterprises) and the promotion of Venture Capital in Croatia (which emphasises the commercialisation of R&D results and the development of private firms and research organisations). BICRO also finances the development of technology centres, incubators and R&D centres (which support the development of local technology-based companies), as well as sponsoring the "Research and Development Programme" (grants for financing of research projects of SMEs) (European Commission, 2004).

In March 2006, the government founded the Croatian Institute of Technology (CIT) under the authority of the MSES. The institute was founded in order to assist the government in its ambitious aim to develop Croatia into a contemporary, S&T oriented economy. In line with the official S&T policy objectives, the role of CIT will be coordinated with the role of the future European Institute of Technology (EIT). Hence, CIT mainly focuses on strengthening the education, research and innovation sectors (i.e. the "knowledge-triangle") by integrating the contributions of various important stakeholders in their unique goal of creating a knowledge society. CIT has also been entrusted to implement TEST (a sub-programme of HITRA - the Croatian Innovation Technology Development Programme, which deals with technology research and development) (CIT, 2006). CIT operates in the field of financial support to technology based and innovative entrepreneurs and coordinates cooperation with European-funded projects. CIT provides consulting services in the area of technology transfer and knowledge, and coordinates institutions in similar areas of work, with the aim of enforcing technological development on a national level. Furthermore, CIT provides expert advice in establishing *start up* and *spin out* companies, whereby the main criteria are innovation, development of new technologies and market logic and profitability of the new companies. CIT's tasks include building a Business Intelligence system and technology forecasting (Government of the Republic of Croatia, 2006d).

Business related affairs are also dealt with within the Euro Info Correspondence Centre (EICC) Zagreb. The main activity of the EICC is to inform, advise and assist SMEs on EU legislation and other non-legal related affairs of practical importance. EICC Zagreb is hosted and financed by the Croatian Chamber of Economy and co-financed by the European Commission. It is part of a large group of more than 260 Euro Info Centres and 13 Euro Info Correspondence Centres located in 40 European and Mediterranean countries (EICC Zagreb, 2006).

Another very important funding body in the field of science is the National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia (NFS). This organisation was established in 2001 with the objective of promoting science, higher education and technology development, as well as strengthening the links between research institutes, higher education institutions and industry. The NFS supports scientific, higher education and technological programmes and projects, with the aim of producing innovations and patents. It also provides student grants and promotes mobility. The NFS contributes to Croatia's transformation into a society of knowledge, enhancing the development of a globally recognised research and knowledge-based economy through the strategic investment in people and ideas essential to outstanding research, and through its support of projects which could foster the development of Croatia (NFS, 2006).

Also important is the National Council for Information Society that monitors the development of an information society. Developing an innovative informational and communications infrastructure is in the domain of the Croatian Academic and Research Network - CARNet and the University Computing Centre - SRCE (Government of the Republic of Croatia, 2006d).

The National Council for Information Society evaluates, establishes, and promotes priorities in the development of information society in the Republic of Croatia, especially implementation of priority measures and development goals (Petrovecki, Paar et al., 2006).

The Ministry of Science, Education and Sport coordinates work with other involved ministries. For example, the Ministry of Economy, Labour and Entrepreneurship manages budgetary funds and adapts policies in education and science to suit economic needs. The Ministry of Defence funds the Institute for Research and Development of Defence Systems. The Ministry of Finance is engaged in removing a number of regulatory constraints in order to create an environment conducive to investors and to promote the development of venture capital in accordance with the government's EU Accession Action Plan (World Bank, 2005b).

Control over the proper implementation of innovation and technology programmes and initiatives is executed by the Interdisciplinary Control Group and the Committee for Ethics in Science and Higher Education (Government of the Republic of Croatia, 2003b; Ministry of Foreign Affairs and European Integration of the Republic of Croatia, 2005). The Committee for Ethics in Science and Higher Education promotes ethical principles and values in science and higher education, business relations and public relations, and also follows up the application of modern technologies and environment protection in scientific research and higher education (Petrovecki, Paar et al., 2006). Other important institutions within the framework of the Croatian innovation system are the National Competitiveness Council founded in February 2002; the Agency for Science and Higher Education; the Agency for Accreditation and Quality Assurance established in 2004; and the Croatian Innovation Council and the Croatian Accreditation Agency, both established in 2005 (National Competitiveness Council, 2004; World Bank, 2005b; World Bank, 2005a). Furthermore, the Croatian innovation system is supported by the Croatian Standards Institute, the State Office for Metrology, the State Office for Intellectual Property Rights and the State Bureau of Statistics. Jointly, the aforementioned institutions create the core technical infrastructure necessary for technological and innovation development (Svarc and Becic, 2006).

Another important professional body is the National Bologna Follow-up Group, that follows up the development and implementation of the Bologna Process at both European level and Croatian higher education institutions and implements activities and projects directed at promotion of the Bologna process in Croatia (Petrovecki, Paar et al., 2006).

Part of the reform of the education system is also founding the Agency for Adult Education - a public institution established by the Decree of the Government of the Republic of Croatia in May 2006. The activities of the Agency include monitoring, development, evaluation and improvement of the adult education. The Agency is established as a part of the Government Strategy for Adult Education, adopted in 2005 and based on the lifelong learning principle. Within the Agency a Centre for Mobility and EU Programmes has been founded. Its primary task is the implementation of the Lifelong Learning Programme - LLP, Erasmus, Leonardo, Comenius and Grundtvig (Agency for Adult Education, 2007).

The Croatian Academy of Sciences and Arts comprises nine scientific departments, 25 councils/committees and 20 research units. The Ruđer Bošković Institute is the most re-nowned non-university public research centre in the country. It is the largest Croatian Research Institute with 830 employees and 578 published research articles (1.13 articles per resident/year). 5% of Croatian researchers are employed at this institute which produces 27% of Croatian World Recognised Scientific Publications (Vikić-Topić, 2007). Scientific centres of excellence are a new feature envisaged by the new Science and Education Act passed in 2003. These centres should comprise groups of scientists or scientific organisations which

have been assessed by relevant evaluation bodies and proclaimed centres of excellence by the minister. As an additional method for encouraging innovation, higher education institutions and scientific institutes establish technology parks in order to commercialise scientific results, encourage cooperation between scientists and the business community, and enhance the knowledge-based economy (Dall, 2006).

Table 2.1: Main S&T Stakeholders of Croatia (Dall, 2006; Becic and Svarc, 2007)

The main ministry in Croatia with control over S&T	<ul style="list-style-type: none"> - Ministry of Science, Education and Sports - National Science Council - National Council for Higher Education
Other ministries with importance to the S&T sector	<ul style="list-style-type: none"> - Ministry of Finance - Ministry of Economy, Labour and Entrepreneurship - Ministry of Defence
Other important stakeholders	<ul style="list-style-type: none"> - Business and Innovation Centre of Croatia (BICRO) - National Foundation for Science, Higher Education and Technological Development - Council for the Financing of Scientific Activity and Higher Education - Croatian Institute of Technology (CIT) - Technology Council of MSES - Croatian Innovation Council - National Competitiveness Council - Committee on Education, Science and Culture - Technology and Innovation Centres (Centre for Technology Transfer (CTT), Zagreb; Technology Centre Split (TCS); Centre for Innovative Technology Rijeka (TIC); Technology and Innovation Centre, Osijek) - Research and Development Centre for Mariculture, Dubrovnik - Agency for Science and Higher Education - Research and Development Technology Institute - Committee for Ethics in Science and Higher Education - National Network for Quality Assurance of Higher Education - Rector's Conference - State Office for Intellectual Property Rights - Croatian Accreditation Agency - Croatian Standards Institute - State Office for Metrology - Agency for Accreditation and Quality Assurance - Central Bureau of Statistics (CBS) - National and University Library - Croatian Academic and Research Network (CARNet)

Other important stakeholders	<ul style="list-style-type: none"> - Institute RUĐER BOŠKOVIĆ - Interuniversity Centre of Dubrovnik - Euro Info Correspondence Centre (EICC) - Agency for Adult Education - Agency for Vocational Education - National Council for Curriculum - National Centre for External Evaluation of Education - National Council for Pedagogical Standard - National Council for Information Society - National Bologna Follow-up Group
Universities	<ul style="list-style-type: none"> - University of Zagreb - University of Split - University of Rijeka - University of Osijek - University of Zadar - University of Dubrovnik - University of Pula

2.2 International Cooperation

Croatia has been experiencing a constant renewal of international cooperation and support, especially in the last years. This cooperation has been substantially supported by many international organisations, as well as through the assistance of developed countries in bilateral programmes (also providing significant benefits to the R&D sector). The largest amount of financial support in this respect came from the funds of the Stabilisation and Association Process, the IPA/CARDS programme, the Stability Pact for South Eastern Europe, the European Investment Bank, and the European Bank for Reconstruction and Development.

The European Union's Tempus programme has been important in the area of higher education, while Croatia's inclusion into the Framework Programmes for R&D and the European Research Area (ERA) has also been of particular significance. Inclusion of the country into the European Investment Bank's Innovation 2000 Initiative ought to prove useful as well. Regarding multilateral cooperation in the area of science and research, Croatia has established close links with many specialised United Nations (UN) agencies, such as UNESCO, UNIDO, UNDP, UNECE¹, while some other international organisations, such as the World Bank, have also been important donors and have helped in the area of R&D (Uvalic, 2006).

The Croatian Ministry of Science, Education and Sports allocates a relatively small percentage of its budget to international S&T cooperation (0.45% in 2001, increasing to 0.62% in 2005) (Becic and Svarc, 2007). In 2006 there were about 176 ongoing international projects, involving approximately 600 researchers, or about 3-4 Croatian scientists per project. The number of research scholarships based on bilateral inter-governmental programmes has been increasing in recent years, and amounted to 143 in 2002. 15 scholarships were awarded under the Marie Curie Programme (mobility within the FP6) in 2004 and 2005. Moreover, there has been an increase in the number of scholarships for foreign researchers coming to Croatia: in 2002, 98 scholarships for 523 research months were granted on the basis of bilateral

¹ Please see the List of Acronyms, chapter 8.

inter-governmental programmes. The most frequent countries and regions participating in exchange of R&D personnel are Slovenia, Hungary, Austria, Germany, France, the United Kingdom, and the USA (Uvalic, 2006).

The European Research Area (ERA) was established with the objective of creating a genuine "internal market" in research in order to increase pan-European cooperation and coordination of national research activities. The main financial instruments of the ERA are the EU's Research Framework Programmes (EurActiv, 2006b). In FP5, Croatian participation was limited, mostly due to its third country status - the European Commission approved only nine projects with consortium members from Croatia. In FP6, although still with a third country status, Croatian partners significantly increased their activities. Between 2002 and September 2005 Croatian scientists submitted 417 project proposals, of which 98 proposals received a positive evaluation and 47 contracts were signed.

Croatia has demonstrated a high absorption capacity for FP6 projects and is one of the most successful countries in the region in terms of its utilisation of EU financial resources. As a fully associated member state, Croatia has participated in FP6 with EUR 6.4 million in 2006, of which EUR 3.18 million was provided by the state budget and the remaining came from the PHARE programme. Between 2003 and 2006, Croatian scientists concluded 95 research contracts with a total value of EUR 7.8 million. Only in 2006, did the total value of research contracts amount to EUR 3.6 million, exceeding the national contribution (Becic and Svarc, 2007). According to statistics, the greatest absorption capacities were in the fields of Information and Communication Technologies, Medicine and Biotechnology, Food Biotechnology, Constructions, Microelectronics and Physics (EurActiv, 2006b).

Following a positive evaluation by the European Commission, partners from Croatia are eligible to request the reimbursement of costs for the MSES proposal preparation. The activities of the National Contact Points for the Framework Programmes are carried out by the MSES Department for European Integration. The dissemination of information about FP6 is mainly performed through workshops at higher education institutions and research institutes, and through video-conferences. In March 2005, the MSES submitted a Memorandum of Understanding for full participation in the FP6 to the European Commission, in order to change the "third country" status into the "associated candidate country" status (Uvalic, 2006). The memorandum was signed in autumn 2005 and consequently, the EC announced that depending on the accomplishment of internal procedures, Croatia can participate as an Associated Candidate Country and receive Community contribution in all FP6 projects contracted after 1st January 2006 (MSES, 2006a).

In 2007 FP6 was replaced by FP7, designed to help the EU fulfil the goals set in the Lisbon Strategy and become the backbone in the construction of the European knowledge economy. FP7 runs from 2007 to 2013, with the main objective of achieving the European Research Area by 2010 (EurActiv, 2006b). On 13th June 2007 the Republic of Croatia (represented by the Minister for Science, Education and Sports, Dragan Primorac) signed Memoranda of Understanding (MoUs) with the European Commission (represented by Commissioner Janez Potočnik) to enable Croatia to participate fully in the EU's Seventh Research Framework Programme (FP7). Associated status allows Croatia to participate in all calls for proposals and compete on an equal footing with the EU Member States for research cooperation and support actions funded by FP7. Although the Memorandum of Understanding entered into force on 13th June, it is applied as from 1st January 2007 (see-science.eu, 2007d).

Croatia is also participating in SEE-ERA.NET - a fully fledged regional ERA-NET coordinated by Austria, and funded by the European Commission for a period of five years. The programme

came into operation on 1st September 2004 and incorporates 17 partners from 14 countries. The Croatian SEE-ERA.NET partner is the Ministry of Science, Education and Sports. The idea behind SEE-ERA.NET is to coordinate existing bilateral science and technology agreements and corresponding unilateral activities, which on their own often lack the level of threshold needed to progress and make unnecessary repetitions. Isolated activities are thus intended to be brought together under a system of flexible multilateral initiatives to support regional RTD cooperation. The regional approach adopted by SEE-ERA.NET was an attempt to compensate for the general lack of regional (i.e. international sub-European) RTD cooperation opportunities. Finally, SEE-ERA.NET aims to bring bilateral cooperation programmes to the level of multilaterally coordinated RTD collaboration activities (Schuch, 2006).

Croatia has been a full member of COST (European Cooperation in the field of Scientific and Technical Research) since 1992; its partners are currently participating in over 50 COST actions co-financed by the MSES. Throughout the last decade, COST has developed into one of the largest frameworks for research cooperation in Europe, with over 200 actions and 30,000 scientists from 46 countries involved in various projects (MSES, 2006a).

Croatian partners have also participated in the EUREKA programme with 15 projects, eight networks, and two cluster projects. Croatia gained full membership status in the EUREKA programme in 2002 and the MSES has co-financed all EUREKA projects that received positive evaluation. National contact points (NCPs) for all mentioned programmes are at the MSES Directorate for International Cooperation (MSES, 2006a). The MSES co-finances EUREKA projects with up to 50% of Croatian participation, or at most EUR 150,000 per project and the rest comes from the partner's side. On an annual basis, the MSES invests EUR 350,000 in EUREKA projects. Although a small investment, it proved to be very efficient due to the fact that EUREKA has strong partners, international recognition, high standard of international evaluation of projects, and flexible administration. First results after five years of participation show that return on investment in EUREKA projects is 4:1 with a good ratio of industry-academia participation (Government of the Republic of Croatia, 2006d).

In the field of higher education, Croatia has been actively involved in the Tempus III programme - the 36 Joint European Projects approved for Croatia include Curriculum Development, Institutional Building and University Management. Up-to-date statistics show that Tempus projects contributed to increased inter-university cooperation (AZVO, 2007).

The Republic of Croatia joined the Bologna Process in May 2001. It has signed the Bologna Declaration and committed itself to modifying its higher education system in order to harmonize it with the European system. This programme supports transformation of doctoral studies in Croatia as essential for further development of higher education and science and for overall development of the country (Government of the Republic of Croatia, 2006d). By the end of June 2005, the most demanding Bologna priority has been fulfilled - the restructuring of all study programmes in accordance with the principles of the Bologna Process. A new method for the recognition of foreign higher education qualifications was also introduced, which is much simpler and faster than the previous nostrification procedure. Last but not least, the creation of the Agency for Science and Higher Education created the institutional framework for the development of the quality assurance system. Four out of seven universities have already established quality assurance offices that will form the National Network for Higher Education Quality Assurance, to be coordinated and overseen by the Agency (Kovacevic, 2006).

The National Foundation for Science (NFS) developed a programme in cooperation with the Croatian Academy of Sciences and Arts, also a member of European Science Foundation

(ESF), to include Croatian scientists in ESF programmes. The main goal of the programme was to include Croatia in the European Research Area. The NFS provides financial support to Croatian scientists - to be eligible, scientists must be citizens of the Republic of Croatia, be working at a Croatian institution, have an independent research career, provide excellence in project leadership and any publications must fulfil the appropriate international standards. The NFS will also finance the inclusion of Croatian scientists in scientific and EUROCORES programmes of the European Science Foundation. An ESF Scientific Programme is a networking activity covering all domains in the research spectrum, bringing together key researchers and research groups to address a major scientific issue at European level. EUROCORES Programmes (European Science Foundation Collaborative Research Programmes) aim to create the conditions necessary for scientific excellence by enabling researchers from different European countries to collaborate and develop scientific synergy (NFS, 2006).

The NFS also provides the so-called EMBO (European Molecular Biology Organisation) Installation Grants. The aim of this new scheme is to strengthen Croatian science by allocating grants to help scientists set up laboratories in Croatia, allowing them to rapidly establish a reputation in the European scientific community. Successful applicants receive EUR 50,000 annually (for 3-5 years) from the NFS via EMBO (NFS, 2006).

NFS is also funding/has funded some other programmes as (Government of the Republic of Croatia, 2006d):

- Training of doctoral students
- 'Partnership in Basic Research' which seeks to increase non-governmental investment in basic research with investments based on public-private partnerships
- 'SCIENCE award' - which has the goal of promoting science and research activities among graduate students/researchers
- Reform of the Education system in Croatia
- Programme 'Brain Gain'

Other international organisations which have cooperated with Croatian partners in the field of science and research include the IAEA (International Atomic Energy Agency) working on infrastructural projects, scientific research and regional projects, as well as having prepared an additional five project proposals for the new biennial project cycle 2007/2008; UNECE (UN Economic Commission for Europe), which established cooperation through work groups and seminars, and participated in an international conference on technology transfer held in Zagreb in 2001; and NATO. There is also ongoing cooperation with the World Bank (TAL-2) within the *Science and Technology Project*, a project of high priority for the development of the national innovation system. Croatian teams participate successfully in various multilateral scientific organisations such as CERN (Geneva), the International Centre for Theoretical Physics (Trieste), and the International Centre for Genetics and Biotechnology Engineering (Trieste) (Uvalic, 2006). The wide range of international organisations which have established cooperation with Croatian scientific institutes in the last decade also includes the ICSU (International Council for Science), the IUPAC (International Union of Pure and Applied Chemistry), the EERO (European Environmental Research Organisation), the ALLEA (All-European Academies), the IAP (Inter-Academy Panel), the IAMP (Inter-Academy Medical Panel) and the UAI (Union-Académique International). Croatian higher education institutions, as well as the Croatian Academy of Sciences and Arts, also have their own cooperation agreements with foreign partners (European Commission, 2004).

Good cooperation has also been established with the German Research Foundation (*Deutsche Forschungsgemeinschaft*) through Research Units (DFG *Forschergruppen*), Collaborative Research Centres (*Sonderforschungsbereiche*, SFBs) and DFG International Research Training Groups (*Internationale Graduiertenkollegs*, IGKs), of which, the Research Units are the most flexible instruments of these coordinated programmes, as they bring together a group of five to ten individual research projects. In the scope of the SFBs, Croatian scientists could theoretically act as project leaders (NFS, 2006).

In the field of intellectual property, Croatia has been cooperating in the CARDS 2002 Regional Project "Industrial and intellectual property rights". The total value of the project was EUR 2.25 million. Although originally envisaged for a duration of three years, the project was later extended in accordance with a European Commission initiative, and expired in December 2006. The focus during the last year of implementation shifted from educational activities to promoting expert cooperation between the region's countries (SIPO, 2006). The programme's objectives has been to ensure a sustainable and self-supporting infrastructure enabling the R&D community to make full use of intellectual property rights and any related commercial exploitation (Vikic-Topic, 2007).

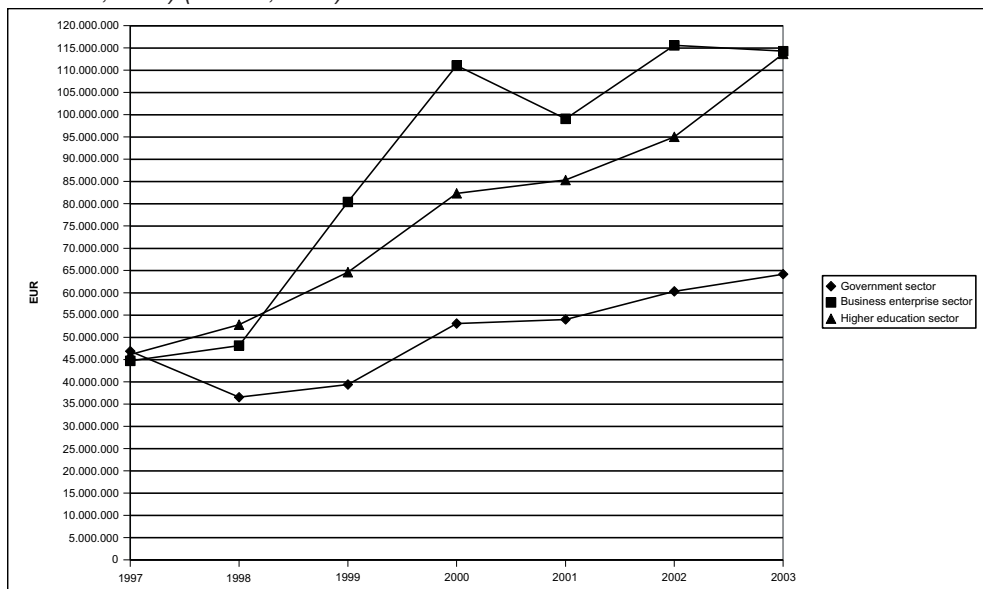
3 The Input Side of the National Innovation Systems

Scientific institutions play a key role in the economic and social development of a country, with state-funded research and educational institutions occupying a particularly central position. The quality and efficiency of their work has a crucial impact on the readiness of the private sector to invest in research and development. A country's ability to develop and maintain its competitive advantage largely results from its public and private sector scientific activities, thus there is no alternative to the continuous and significant investment in science, regardless of the source of funding (budgetary or non-budgetary). According to leading world experts, economic growth in this century will be driven by sectors with dominating high levels of technology, which highlights the need to further increase investments in science and innovation (Government of the Republic of Croatia, 2003a).

3.1 Development of Financial Resources Allocated to R&D

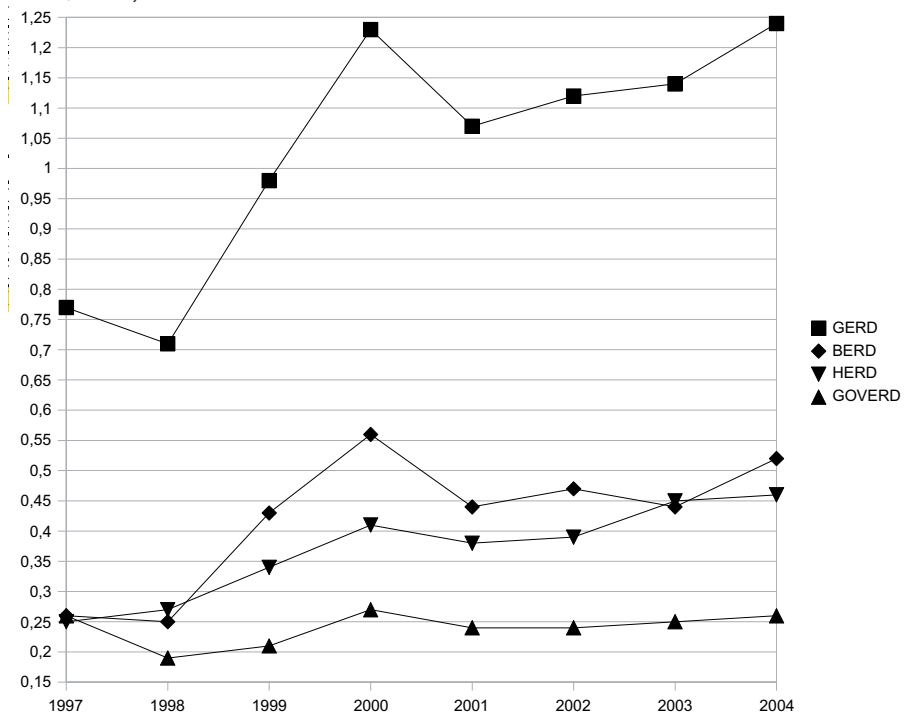
Regarding the general situation in the field of science, research and innovation in Croatia, various studies have shown that the country is still considerably behind the EU countries. The difficult economic situation and the collapse of major businesses brought about an end to corporate financing of R&D and largely severed the links between higher education institutions and professional R&D organisations. Furthermore, those companies that did survive the difficult transition period rarely preserved their internal R&D as a resource for strategic development. Nevertheless, Croatia invests rather higher resource in R&D, General Expenditure on Research and Development (GERD) in 2004 was 1.24% of GDP ((Svarc and Becic, 2006), and surpasses the R&D intensities of some EU member countries, such as Greece, Portugal, Spain and Italy (0.68%, 0.77%, 0.96% and 1.11% respectively; 2002) and the R&D intensities of most of the newly accessed countries (apart from Slovenia and the Czech Republic). According to DG Research, the EU-15 average in 2001 (GERD as % of GDP) was 1.98% (Government of the Republic of Croatia, 2006a). Compared to the other Western Balkan countries, Croatia has the highest R&D intensity and is one of the few with detailed statistics on R&D expenditure by sector (government sector expenditure - GOVERD, business sector expenditure - BERD and higher education expenditure - HERD).

Figure 3.1: Dynamics of Expenditure on R&D per Sector (Central Bureau of Statistics Croatia, 2006) (Fischer, 2006)



These measures are presented in Figure 3.2 as a percentage of GDP (compiled by Svarc and Becic).

Figure 3.2: Dynamics of Expenditure on R&D as Percentage of GDP per Sector (Svarc and Becic, 2006)



3.2 Government Sector Expenditure on R&D

It is obvious that the investment in Croatian science today is characterised by many weaknesses and structural problems.

One of the most striking particularities in this respect is the domination of the public sector over the private sector in S&T. As reported in 2004, the higher education and government sectors combined employ the vast majority of researchers in Croatia, almost 85%, and together invest 0.7% of the GDP in research and development. This represents a respectable pool of national knowledge and expert skills. However, the business sector in Croatia employs a modest 15% of researchers and invests 0.44% of GDP. The contribution of the private sector to GERD is 42%, while the state contributes 55% of GERD (Becic and Svarc, 2007).

Another problematic feature is the structure of the MSES budget. In most developed countries, the ratio regarding the proportion of salaries to investments to expenses is approximately 40:30:30, whereas in Croatia, the ratio is 55:12:33. It indicates that presently the emphasis is on maintaining S&T base and enlargement of number of researchers instead of capital investments in research infrastructure (Becic and Svarc, 2008).

Between 1997 and 2002, a slight upward trend has been registered in available financial resources from the Ministry's budget for science. Since 2003 the share of total expenditure for science as a percentage of the MSES's total budget has been about 9% and is increasing continually.

However, in terms of the share of GDP, GOVERD (the Government Sector Expenditure on R&D) has remained more or less constant, fluctuating at around 0.26% of GDP from 1996 to 2004 (Svarc and Becic, 2006).

However, some experts report on the increase of the Croatian Government's investments in the sector of education and science. According to Petrovečki and Paar (Petrovečki, Paar et al., 2006), the Government has increased the MSES budget by 33.7% over the 2003-2007 period. In the last four years, the national budget allocated for education and science has increased by EUR 360 million.

Some new areas, such as technological development and informatics, have received a financial contribution from the budget since 2000, while the increased budgetary funds have also permitted an increase in the number of projects financed in all six scientific disciplines, especially in Medical Sciences, Technical Sciences and Humanistic Sciences - in each case, the number of projects during 1996-2003 has almost tripled (Uvalic, 2006).

Croatian experts are warning of the possible dangers if the country fails to pursue its planned increase in investments - inevitably this would jeopardise not only the recovery of Croatian science, but also the competitiveness of the whole economy, triggering long-term negative effects (Government of the Republic of Croatia, 2003c).

Table 3.1: Budget for Research Projects Financed by the MSES, by Fields of Science 1996-2003 (MSES, 2005b)²

Science discipline	Number of projects 1996	Number of projects 1997	Number of projects 1998	Number of projects 1999	Number of projects 2000	Number of projects 2001	Number of projects 2002	Number of projects 2003	Funding (in Euros) 2003
Natural sciences, Mathematics	193	215	221	223	230	240	306	316	4.043.438
Technical sciences	134	227	249	251	271	290	327	344	3.004.543
Medical sciences	124	190	206	209	239	267	387	436	4.682.107
Biotechnical sciences	76	113	119	119	125	131	153	173	1.610.453
Social sciences	93	133	148	155	167	182	219	261	1.609.931
Humanistic sciences	85	120	130	148	159	179	245	269	1.663.329
Total	705	998	1073	1105	1191	1289	1637	1799	16.613.801

142.5 million HRK (Croatian kuna)³ is reserved in the state budget for the financing of science projects in 2007. This is a 34% increase of 48.7 million HRK since 2002 (Vikic-Topic, 2007).

Table 3.2: Financing of science projects from the budget of MSES in million HRK according to Vikic-Topic, MSES (Vikic-Topic, 2007)

2002	2003	2004	2005	2006	2007	Increase 2002/2007
93.72	112.86	115.84	118.98	126.04	142.5	34%

R&D expenditure broken down by type of activity in the government sector in Croatia (2003) was allocated in basic research (68%), applied research (27.8%), and experimental development (4.1%). The European average in the same year was 46.1% in applied research, basic research 30.9%, and experimental development 22.3%. Of course, the European averages mask differences at the national level, especially in the government sector, for example, basic research was the main activity in most of the New Member States (2004 and 2007 enlargements) (Wilén, 2007).

3.3 Business Sector Expenditure on R&D

Business expenditures on R&D is particularly important in science-based sectors (pharmaceuticals, chemicals and some areas of electronics), where most new knowledge is created in or near R&D laboratories (European Commission, 2005a).

The business sector in Croatia invests 0.41% of GDP (2005), which means it ranks well amongst countries of the region, but its position is still unfavourable in comparison to the EU average. The business sector of the EU-27 invests more than 1.1% of GDP (an average of 1.17% in the year 2005, ranging from 0.11% in Bulgaria to 2.92% in Sweden).

² The data have been converted into EUR according to the exchange rate on 31st December of each year on <http://ec.europa.eu/budget/infoneuro/>

³ 142.5 million HRK is EUR 19.47 million., 48.7 million HRK is EUR 6.65 million, 93.72 million HRK is EUR 12.81 million, 112.86 million HRK is EUR 15.42 million, 118.98 million HRK is EUR 16.24 million HRK, 126.04 million HRK is EUR 17.23 million.

The business sector's input into R&D activities in comparison to overall R&D activity reveals the relative importance of profit-oriented knowledge creation and absorption. Recent statistical data and analysis about R&D activities and costs by countries of the EU reveals that within the EU-27, each sector is more or less specialised in a particular type of R&D activity: the business enterprise sector in experimental development, the higher education sector in basic research and, to a lesser extent, the government sector in applied research (Wilén, 2007).

Table 3.3: R&D expenditure in EUR million and by type of activity as a percentage, all sectors, EU-27 and selected countries, 2003 (Wilén, 2007; Becic and Svarc, 2008)⁴

	Total	Applied Research	Basic Research	Experimental development	Not classified
EU-27	188 973 s	35,2 s	23,1 s	41,4 s	0,2 s
HR	292	33,5	36,4	30,2	:
AT	5 250	36,3 i	17,5 i	44,3 i	1,9
JP	119 748	21,3 i	12,6 i	61,0 i	5,1
US	258 519 ip	23,2 p	18,5 p	55,4 p	3,0

Source: Eurostat - R&D statistics, OECD MST⁵

As shown in Table 3.3, the breakdown of R&D expenditure in EU-27 by type of activity hides differences at the national level.

At the EU-27 level in 2003 in the business enterprise sector, 57% of business R&D expenditure is allocated to experimental development, 37% to applied research, and only 5% to basic research. This seems logical since the aim of both experimental development and applied research is to produce new goods or, at least, to create the expectation of a practical use in the near future (Eurostat, 2004; Wilén, 2007). The same trend was noted on the national level in Croatia. The highest share of business R&D expenditure was allocated to experimental development with 63%, while applied research received 35% and basic research only 2%.

3.4 Higher Education Sector Expenditure on R&D

University research represents one of the key activities within the higher education sector regarding the national innovation systems, providing scientific and technological knowledge to be disseminated in and utilised by the economy. However, as primary suppliers of fundamental research, higher education institutions do not only contribute to the economy through the direct provision of applicable results, but also through the diffusion and adoption of skills and techniques and through professional networks and other forms of communication channels created by academic research. Taking account of the various tasks of the higher education system, as well as the challenges of a knowledge-based society, a large increase in public sector R&D spending on the higher education sector is required (Fischer, 2006).

Statistical data shows that Croatia mainly satisfies this expectation. According to data compiled by Fischer, Croatia spent EUR 46.1 million on higher education in 1997, this amount doubled in 2000 to EUR 82.3 million, and reached EUR 113.7 million in 2003. Croatia also had the highest level of HERD relative to GDP (0.45% in 2003) compared to the other countries

⁴ For general abbreviations used in the table please see chapter 8 List of Acronyms.

⁵ Exceptions to the reference year: 2004: AT and CH

EU-27: Distribution by type of activity is estimated on the basis of available Member States.

AT, SE and JP: Underestimated or based on underestimated data.

PL, RO and RU: Excludes most or all capital expenditure.

of the region, a level which is on a par with the EU-15 average (0.42% in 2003)⁶. If population is taken into account, Croatia is once again the leading country in the region with EUR 25.6 per capita in 2003. Although Croatia is slowly catching up, it is still investing less per head than Portugal or Greece for example (EUR 31 and EUR 37 per capita respectively in 1999) (Fischer, 2006; Becic and Svarc, 2007).

According to Eurostat, statistical data shows that in Croatia basic research was the main type of activity in the higher education sector, allocated 53.4% (2003) of government R&D expenditure, while applied research received 34.7%. The same trend is already noted at EU-27 level, where basic research is given 72.8%, and applied research 21.7% (Wilén, 2007).

The comparison between Higher Education R&D Expenditure and other sources of funding can be observed in Figure 3.1.

3.5 R&D Infrastructure

Modernisation and renewal of R&D infrastructure are among the key priorities of policymakers throughout the Western Balkans region, including Croatia. These initiatives include purchasing new equipment, modernising laboratories and research facilities, promoting ICT systems, updating bibliographical databases and supplying university libraries with specialised literature. The main obstacle preventing a faster pace of reform is the limited financial resources. Private funding from the enterprise sector remains low and international donors show little interest in the modernisation of research facilities and laboratories (Uvalic, 2006).

Nevertheless, positive trends can be observed, especially in Croatia, which has recently been investing heavily in scientific infrastructure and technical equipment, funded by the large capital investment loans taken out by higher education institutions. The Ministry of Science, Education and Sports has allocated over EUR 30 million in equipment grants since 2002, significantly improving the technical equipment at higher education and research institutes. The private sector has also made significant investments in the research infrastructure, particularly in the pharmaceutical and the telecommunications sector. However, significant investments are still needed, especially in higher education institutions outside Zagreb. Croatia still lacks large research equipment, some of which is compensated for through international cooperation schemes.

Regarding computer networks, the Ministry of Science, Education and Sports established CARNet (Croatian Academic and Research Network) in 1991. One year later Croatia obtained its internet domain (.hr) and the MSES is demonstrating a high level of awareness regarding the importance of the information society. In 2006, 176 institutions at 263 locations in 31 towns throughout the country, were connected to CARNet (with links of 2Mbit/s and more), including all scientific and higher education institutions. The capacity of the CARNet link with the rest of the world is 622 Mbit/s. CARNet is working intensively to promote "Open Access", encompassing all scientific publications, dissertations, research outcomes etc., regardless of whether the user's library or institution is subscribed to a certain scientific magazine, thus making scientific resources accessible to the widest range of users. CARNet plays multiple roles in the education system - it encourages the use of new technologies in the learning process, providing its users with concrete help through the purchase of software and project-financing (CARNet, 2006).

The University Computing Centre (SRCE), founded in 1971 by the University of Zagreb, is

⁶ Data was updated based on the latest available data from EUROSTAT during a review by Becic/Svarc.

the oldest infrastructural institution for establishing and using Information and Communication Technologies (ICT) in the academic community - today it is one of the foundations for planning, designing, establishing, maintaining and using the ICT system in Croatia's academic community. SRCE encourages intensive cooperation between all institutions involved in establishing information infrastructure and using ICT in the Republic of Croatia, especially with the MSES and CARNet. Moreover, the University Computing Centre has been actively participating in international (mostly European) Information Technology projects for more than 30 years. SRCE actively participates in EU projects like EQIBELT - Education Quality Improvement by E-Learning Technology, GEANT2 - a multi-gigabit pan-European data communications network, reserved specifically for research and education use, and EGEE II - Enabling Grids for E-science (SRCE, 2006).

The Ministry of Science, Education and Sports financially supports the establishment and operation of referral centres for issuing programme licences to different branches of science (for example, Mathematica, Matlab, Statistica and SIS). The Scientific Information System (SIS) organises and finances the design of an information system, allowing any member of Croatia's academic and research community to get scientific and research information. Furthermore, the SIS supports the on-line database centre (Internet access to commercial reference databases) and CROSBİ (Croatian Scientific References - data on scientific papers published by Croatian scientists) (MSES, 2006b).

The National Library Information System (NİSKA) is a joint project of the Ministry of Science, Education and Sports and the Ministry of Culture, launched in 1996. NİSKA connects all libraries in Croatia, irrespective of their type (school, university, scientific and city libraries), with the aim of establishing a system that will enable the collections of all libraries to be accessible to both the Croatian public, and the foreign public, in electronic, multimedia format.

The Young Scientists Network (MLAZ) was established in 2005 with the objectives of promoting and improving the role of postgraduate students and young scientists in society, enhancing the exchange of information and ideas, encouraging national and international cooperation, and stimulating legislative initiatives etc. On the European level, MLAZ actively cooperates with EURODOC (European Council of Doctoral Candidates and Junior Researchers) and WAYS (World Academy of Young Scientists) (MLAZ, 2006).

3.6 Human Resources in R&D

Human resources play a key role when it comes to knowledge production and, subsequently, economic and technological development, thus their current state and future potential are of critical importance. The quality of human resources is a major determinant of knowledge creation and the transmission and application of new knowledge. Generally, indicators of human resources are divided in two groups: education and learning, and employment (Aralica and Bacic, 2005). According to Fischer, the availability and quality of human resources (being both producers and users of knowledge) in S&T, are crucial elements on the path towards a knowledge society (Fischer, 2006). Awareness of the importance of scientific activity in the overall development of a state is clearly demonstrated by the increasing number of people with a higher education and the intensified employment opportunities for young scientists. Within this category, Croatia ranks relatively well in comparison to other countries of the region, but not compared to the EU average (Aralica and Bacic, 2005).

In 1990, the number of full-time employees in R&D was 18,361, of which 8,772 were researchers. In 1999, these values had dropped to 10,764 and 6,805 respectively, showing a severe fall in both the total number of R&D employees and the number of researchers during

the last decade. However, this decline is still smaller compared to other transitional countries, including some new EU member states such as the Czech Republic. The distribution of scientists by different scientific fields according to the data of the Croatian Central Bureau of Statistics (CBS) is illustrated below.

Table 3.4: Researchers by Scientific Fields (HC)⁷, in 2001 and 2005 (Becic and Svarc, 2008)

Scientific Field	2001		2005	
	Number	%	Number	%
Natural sciences	1,517	15.3	1,402	13.5
Technical sciences	2,784	28.1	2,421	23.4
Medical sciences	1,714	17.3	2,523	24.3
Bio-technical sciences	788	8.0	941	9.1
Social sciences	2,282	23.0	1,953	18.8
Humanities	823	8.3	1,127	10.9
Total	9,908	100.0	10,367	100.0

Source: CBS, R&D Annual Report

Another key indicator of the S&T sector's structure is the qualification of the research personnel. The share of researchers with academic degrees in Croatia demonstrates how highly qualified the country's scientific personnel is, with more than half of all researchers holding a PhD degree. According to the Croatian CBS, there were 973 new Masters and Masters of science (MSc) titles awarded in 2005 and 385 Doctors of science in the same year. These numbers have remained more or less constant, with slight annual growth in recent years (Central Bureau of Statistics Croatia, 2006).

Table 3.5: Qualification Structure of Researchers in 2005 (Becic and Svarc, 2008)

Academic Degrees	2005	
	Number	%
B.A, B.Sc.	2,377	22.9
M.A, M.Sc.	1,938	18.7
Ph.D., Dr.	6,052	58.4
Total	10,367	100.0

Source: CBS, R&D Annual Report

The number of new graduates with training in science and engineering (S&E) is indicated using the number of tertiary S&E graduates.⁸ Degrees in the S&E fields of study formally qualify their holders for employment as researchers, scientists and engineers. The most recent Eurostat publication of *Science, Technology and Innovation in Europe (2007)* provides statistics up to 2004 regarding the percentage of graduates in S&E. This report shows that of the 147,000 Croatian graduates in 2004, 23% of these were in the area of S&E (Eurostat, 2007). While this is comparable to the European average, Croatia still falls well behind when it comes to the number of S&E graduates per 1,000 population aged 20-29, as calculated by the European Innovation Scoreboard. This shows that in 2005 (the most recently recorded year), S&E graduates in Croatia numbered 5.7 per 1,000, far lower than the EU-25 average

⁷ HC - Headcount data

⁸ Science compiles science, mathematics and computing fields of study and Engineering compiles engineering, manufacturing and construction fields of study.

of 12.9 and the equivalent amount in the newly-accessed member states of Bulgaria and Romania, with 8.6 and 10.3 respectively (MERIT/JRC, 2007), and only marginally higher than the amount recorded in 2004. This is a situation that Croatia aims to ameliorate, following the Action Plan for S&T policy of the Republic of Croatia 2007-2010, by increasing this by 12% annually (Ministry of Science Education and Sports of Croatia, 2007).

According to the Eurostat database for tertiary education graduates, in the EU-25 in 2004, 10.5% of all graduates were in the fields of Science, Mathematics and Computing, compared to 5.6% in Croatia in the same year (but 7.3% in 2003). In the EU-25, 13.1% of students graduated in the fields of Engineering, Manufacturing and Construction, which is comparable with the 12.3% in Croatia (Becic and Svarc, 2007).

According to Fischer, around 30% of all students in Croatia in 2003/2004 were enrolled in science, engineering and technology programmes (science students with 26.08% account for most of the S&E students). There has also been a constant increase of S&E students in Croatia between 1997 and 2003 with an annual growth rate of 7.2% (Fischer, 2006). However, it is important to stress that the high share of S&E graduates only reflects the orientation of the Croatian education system and not necessarily its quality. Until quite recently, life-long learning in Croatia was rather neglected and the population with tertiary education was much lower than the EU average. The reason behind this could be the absence of any cooperative links between higher education institutions and the business sector (Aralica and Bacic, 2005). But there have been significant increases in these areas, for example, the population with tertiary education rose from 18.2% of working age population to 21.6% in the period 2002-2005 (MERIT/JRC, 2007).

Generally, the largest part of research activities in terms of human resources and research institutions in Croatia is within the higher education sector, which makes up about 44% of all the research institutions and employs from 50% to 60% of all researchers. The university sector and the public science institutions make up almost 80% of all research institutions and employ 85% of all researchers in Croatia (Kovacevic, 2006).

Another important indicator of human resources in R&D is the share of researchers in the labour force. Since countries differ considerably in terms of their population and labour force sizes, this indicator signifies the relative importance of RSE jobs (Researchers, Scientists and Engineers) in the labour market and can thus be seen as an appropriate indicator of the knowledge base of an economy (Fischer, 2006). According to the CBS and Eurostat (2004), Croatia has reported 2.6 researchers per 1,000 labour force, which is below the EU-15 average of 4.74 researchers per 1,000 labour force and far below the average of EU-25: 3.9 researchers per 1,000 labour force in the same year (Becic and Svarc, 2008).

There have been 7,140 full-time equivalent (FTE) researchers in 2004, 52% of whom were employed in the higher education sector (plus 34% in the government sector and 14% in the business sector). The distribution of FTE by sectors at national level in Croatia is different to the EU-25 where only 37% (2004) of researchers (FTE) are employed in the higher education sector (13% in government sector and 50% in the business sector). The ratio in Croatia indicates those typically working part-time as researchers and full time as teaching staff. According to CBS data, this ratio in Croatia fluctuates at around 54% (2002-2005), demonstrating that on average, Croatian R&D personnel were generally employed part-time in any given R&D job (Becic and Svarc, 2008).

Table 3.6: Researchers by Full-time Equivalent (FTE), by sector (Becic and Svarc, 2008)

	2002	2003	2004	2005
Business sector	1,253	913	1,015	707
Government sector	2,022	2,158	2,420	1,899
HE sector	5,297	2,790	3,705	3,117
Total	8,572	5,861	7,140	5,723

Source: CBS, R&D Annual Report

Table 3.7: R&D Personnel (HC), by Scientific Field (MSES, 2005b; Becic and Svarc, 2008)

	1998	1999	2000	2001	2002	2003	2004	2005
Natural sciences, Mathematics	1,776	2,146	2,359	2,467	2,523	2,363	2,441	1,972
Technical sciences	3,881	4,281	4,242	3,969	4,217	4,335	5,119	4,440
Medical sciences	1,469	1,822	2,245	2,353	3,731	4,127	4,231	3,408
Biotechnical sciences	1,273	1,333	1,320	1,496	1,751	1,708	1,928	1,666
Social sciences	1,908	2,539	2,679	2,905	3,422	3,831	4,747	2,966
Humanistic sciences	554	980	983	927	871	852	1,273	1,575
Total	10,861	13,101	13,828	14,117	16,515	17,216	19,739	16,027

Source: CBS, R&D Annual Report

Table 3.8: Number of Doctors in R&D, by Scientific Field (HC) (Uvalic, 2006; Becic and Svarc, 2008)

	1998	1999	2000	2001	2002	2003	2004	2005
Natural science	569	678	683	648	739	757	770	897
Engineering	718	799	938	856	880	868	942	1,105
Medical science	212	304	522	416	705	1,068	1,079	1,529
Biotechnological science	305	322	358	364	361	356	416	519
Social science	409	667	685	698	726	762	816	1,303
Humanities	131	389	378	408	359	397	436	699
Total	2,344	3,159	3,564	3,390	3,770	4,208	4,459	5,353

Source: CBS, R&D Annual Report

MSES is taking special care to attract the best students to take up research careers. Integration of young scientists into the scientific community is conducted under a special program called the "Young researchers' scheme". Since 2004 a total of 1,084 new jobs for young researchers have been created. One measure is the opportunity for young researchers to use subsidised housing loans with the interest rate of 4.4% or 4.9%. The user pays the interest rate of about 1.7%, and the MSES subsidises the rest. By 2006, approximately 2,000 subsidized housing loans were approved (Kovacevic, 2006).

Like other countries of South Eastern Europe, Croatia could not avoid the phenomena of brain-drain in the last decade. In addition to the massive and continuous brain-drain, the region has also experienced negative effects from brain waste (specialists leaving their professions for better paid jobs in the private and/or informal sector of the economy). In response to this severely damaging trend, UNESCO (in cooperation with HP) launched

the Piloting Solutions for Alleviating Brain Drain in South Eastern Europe in 2003, in order to provide higher education institutions with grid computing technology and to provide financial support to encourage young scientists to remain in the region and cooperate with the diaspora. More specifically, the project aims to re-establish links between researchers who have stayed in their native countries and those who have left (with a focus on IT and physics) by connecting scientists with international colleagues and university resources. Staff and students at beneficiary universities are able to interact with the international scientific community, working on major collaborative research projects with other institutions around the world. As a result, higher education institutions in South Eastern Europe can bid for public and private sector funded research. The project also helps encourage scientists to remain in the area to continue their research (UNESCO & Hewlett Packard, 2003).

Two years after its creation, the joint UNESCO-HP project has resulted in the development of websites, databases and new research projects at several of the higher education institutions involved. Moreover, faculties and students from across South Eastern Europe have explored collaborative efforts with their international colleagues and improved research capacities, encouraging scientists to remain in the region. At the University of Split, UNESCO representatives linked the faculties of Natural Sciences, Mathematics and Education, creating various possibilities for active participation in European projects and providing an opportunity to use EU funds to develop and expand as an institution. Hewlett Packard resources have helped the university to use new high-tech equipment and a number of new activities and projects. In addition to other activities, the University of Split created a database and an interactive website of Croatian physicists around the world to share information with educational and research institutions abroad (UNESCO & Hewlett Packard, 2003).

The National Foundation for Science, Higher Education and Technological Development has also funded a programme, Brain Gain, which aims to repatriate Croatian scientists living abroad, permanently or temporarily (Government of the Republic of Croatia, 2006d).

Following the First Congress of Croatian Scientists from the Homeland and Abroad, organised in Zagreb and Vukovar on 15th-19th November 2004, by the Ministry of Science, Education and Sports, a programme called 'Unity Through Knowledge' was conceived. Given the strength of the Croatian scientific diaspora, an exemplary execution of the programme could have a significant international impact (Government of the Republic of Croatia, 2006d).

The Unity Through Knowledge Fund (EUR 5 million) was established with the purpose of enabling scientific and research work in Croatia for Croatian scientists and researchers working abroad, as well to enable their return to Croatia. The Fund supports 4 activities (Vikic-Topic, 2007):

1. To encourage Croatian diaspora to do science research in Croatia;
2. To establish a network of Croatia scientific diaspora;
3. To conduct short visits of prominent Croatian researchers to Croatia;
4. To encourage the Croatian diaspora to establish new commercial companies for advanced technology in Croatia.

The expected duration of the fund is until the end of 2009 (Vikic-Topic, 2007).

One of the initial goals, to create a Network of the Croatian scientific diaspora, is already underway, following the establishment of the Croatian Science Portal⁹, as described in

⁹ See www.znanstvenici.hr

chapter 4.2 (Government of the Republic of Croatia, 2006d). This portal has instruments to bring science closer to the public with forums, news items and expert opinions. Its goal is to consolidate information useful to the scientific community, to enable linkages between Croatian scientists in Croatia and abroad and to encourage their cooperation. The project is financed by the MSES and it is administered by Ruđer Bošković Institute, University Computing Centre (SRCE), National and University Library and Croatian Academic and Research Network (CARNet) (Vikic-Topic, 2007).

4 The Output Side of the National Innovation Systems

The output of an innovation system is manifested through the new knowledge, new products and new processes which are produced. Whereas indicators such as the 'Gross Expenditure on Research and Development' (GERD) and the 'Number of Researchers' provide a measure of the resources allocated to the innovation system, this chapter focuses on the results of the innovation system and its output indicators, such as patents and scientific articles published.

4.1 Patenting Activities in Croatia

Among other approaches (Hörlesberger, 2006), innovative output can be measured by patent data, the most important advantage of which, is the wealth of the information supplied. A patent file granted by the European Patent Office (EPO) provides data on the invention, which is protected by the patent through the title, abstract and technological classification. Furthermore, patent data provide the only output measure available for almost all countries in the world, including the Western Balkan countries (Hörlesberger, 2006). Patenting behaviour in countries of South and Eastern Europe has undergone a process of change of the same degree and scope as other transitional changes which started in 1989. Nevertheless, the patenting of inventions has become an important part of business activity in the new innovative climate, contributing to the process of innovation capacity building in the region (Kutlaca, 2002).

European inventors today have access to alternatives when seeking patent protection for their inventions: the European Patent Office (EPO), the World Intellectual Property Organisation (WIPO), the World Trade Organisation (WTO) and national patent offices. The EPO provides patent protection through a single procedure, defining the granting of patents in some or all of the contracting states of the European Patent Convention (EPC). In contrast to national patents that are valid in only one country, a European patent gives its proprietor equivalent rights to a national patent in each member state. Moreover, European patents may also be effective in some countries that have not yet acceded to the EPC but that have signed a "Cooperation and Extension Agreement" with the EPO. Croatia was one such country since 2004 but since 1st January 2008, the EPC now also applies to the Republic of Croatia (SIPO, 2007b). Articles 99 to 109 of the Croatian Patent Act, enforced since January 2004, govern the extension of European patents in the Republic of Croatia (European Patent Office, 2006).

The World Intellectual Property Organisation (WIPO) offers inventors and industries a simplified, cost-effective route for obtaining international patent protection. By filing a single "international" patent application under the Patent Cooperation Treaty (PCT), protection for an invention can be sought simultaneously in more than 125 countries (WIPO, 2005).

However, the costs associated with a patent application can result in a further barrier to patenting. Although it is difficult to calculate precise figures, estimates start from EUR 2,000 to EUR 14,000-20,000 for more complicated patent applications. Studies estimate that the

cost of an application and the 10-year maintenance of a patent at the EPO are approximately EUR 32,000 (Roland Berger Market Research, 2004). Applications to national patent offices, in contrast, may be less expensive (Hörlesberger, 2006). Whether an inventor decides to file an application at a national patent office or at the EPO will depend, among other factors, on the countries where he/she wishes to commercialise the invention (European Patent Office, 2006).

The most important body with responsibilities in the field of protection of intellectual property rights in Croatia is the State Intellectual Property Office of the Republic of Croatia. The Office carries out procedures for granting industrial property rights (patents, trademarks, industrial designs, geographical indications and designations of origin, topographies of semiconductor products) and performs the accompanying professional and legislative activities. In addition to the legislative and professional activities, including the procedures for granting rights, a significant segment of the Office activities involves the provision of information and services in the field of intellectual property, the cooperation with other institutions for the enforcement of intellectual property rights and support of innovation activity, as well as the cooperation with economic and R&D entities (SIPO, 2006).

According to Uvalić, the number of patent applications in Croatia has substantially increased during the last years, reaching 1,086 applications in 2003. However, the number of applications that have actually been granted a right to patent has generally been declining and is very low - only 13 in 2003, which is probably a result of the stricter criteria used in recent years (Uvalić, 2006). The number of patents granted directly reflects the registration of innovative ideas. Many experts believe a parallel can be drawn between the economic growth of a country and an increase in the number of patents.

Table 4.1: Number of Patents, 1996-2003 (Uvalić, 2006)¹⁰

	1997	1998	1999	2000	2001	2002	2003
Number of patent applications	697	645	398	884	959	1,034	1,086
Number of granted patents	228	190	78	133	122	59	13

Patents in Croatia are granted by the State Intellectual Property Office. At the turn of the millennium, the number of patents in Croatia was still negligible, with an innovation coefficient ten times smaller than the EU-15 countries (and as much as fifty times smaller than countries traditionally characterised by high levels of innovation such as Finland, Ireland or the USA). Interestingly, on each patent application in Croatia there are 100 internationally refereed publications (Government of the Republic of Croatia, 2003c). A total of 14,223 patent applications have been filed with the State Intellectual Property Office in Croatia between 1st January 1992 and 19th December 2007 (5,670 from residents and 8,553 from non-residents), while between 1st January 2007 and 19th December 2007, 436 patent applications have been filed (342 from residents and 94 from non-residents (SIPO, 2007a).

¹⁰ Source: State Intellectual Property Office of the Republic of Croatia, www.dziv.hr

Table 4.2: Number of Croatian Patent Applications to the EPO, 1998-2004, (Becic and Svarc, 2007).

Indicator	1998	1999	2000	2001	2002	2003	2004 (est)
Total number of patent applications to the EPO	20.83	18.37	14.53	22.02	36.83	38.53	48.40
Number of patent applications to the EPO per million inhabitants	4.628	4.034	3.271	4.962	8.287	8.674	10.897
European high-technology patents (per million inhabitants)	0.444	0.292	:	0.300	0.788	0.074	0.315
Number of patents granted by the USPTO per million inhabitants	3.193	1.763	3.546	3.242	:	:	:

Croatia has made progress regarding the number of patent applications to international organisations like the EPO and USPTO (see Table 4.2). In comparison with EU member countries, countries such as Lithuania, Latvia, Romania, Slovakia, Bulgaria, Estonia as well as countries like Cyprus or Portugal fell behind Croatia in terms of their total number of patent applications to the EPO in 2003. The statistics show that as regards the number of patent applications to the EPO per million inhabitants, the situation is very similar, behind Croatia are countries such as Bulgaria, Estonia, Czech Republic, Greece, Cyprus, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Turkey. However, Croatia occupies an unfavourable position regarding European high-technology patents per million inhabitants in comparison with EU-15 countries (according to the EPO statistics data). This unfavourable position could be improved through the promotion of patenting in companies using financial provisions provided by the government (Aralica and Bacic, 2005; Becic and Svarc, 2007). An analysis of Croatia's position according to the number of patents granted by USPTO per million inhabitants for most recent available data (2000) shows that many new EU member states (excluding Hungary and Slovenia) lag behind Croatia with its 3,065 patents per million inhabitants (Becic and Svarc, 2007).

4.2 Publication Activity in Croatia

There has been a substantial increase in the number of scientific publications in Croatia, in particular in the natural and medical sciences, where the number in both cases has doubled between 2001 and 2003. However, it is quite the opposite in scientific disciplines, such as Biotechnological sciences, where the number of publications has declined. The largest number of scientific publications is produced by researchers in the higher education sector (around 65%).

The Croatian Science Portal is home to several relevant initiatives (Petroveck, Paar et al., 2006):

- A database of Croatian scientific bibliography (CROSBI): Database of scientific and technical publications by Croatian scientists.
- A *Who's Who* in Croatian Science: Interactive interface for scientists to enter their own data and thus make them publicly available, while access and search of the database is open to public.

- On-line access to Croatian scientific publications (Croatian publications portal HRČAK): Includes all Croatian scientific and professional journals on an open-access basis. The management system of this web-service helps editorial offices to post electronic versions of their journals.
- The Open Access/Archives initiative: The basic purpose is to allow a free flow of scientific publication among scientists from different scientific disciplines via the Internet.

The Ministry of Science, Education and Sports launched CROSKI - the Croatian Scientific Bibliography project - in 1997, with the objective of collecting data on the scientific output of the current research projects financed by the MSES, and making them publicly available. CROSKI stores scientific papers published from 1997 to the present day. There are over 144,000 records in the CROSKI bibliography. Its bibliography has improved the publicity of scientific output, creating a positive impact on the scientific community, as well as establishing a permanent archive. There is now a comprehensive overview of all literature produced by Croatian scientists: journal articles, books, book chapters, conference papers, theses, reports, manuscripts, etc. Very often scientists submit their data to the database even before the paper has been published. Furthermore, CROSKI provides a digital archive of full-text papers and offers "on demand" access to institutions and scientists. Librarians are also active in database maintenance – they correct the data and communicate with scientists in order to improve the accuracy of the data. CROSKI has gradually evolved into a comprehensive bibliography, covering all scientific publications in Croatia. The data stored in the database are used for various purposes, such as in annual project reports to the MSES, new project application evaluations, and for scientific advancement (CROSKI, 2008).

Table 4.3: CROSKI, Statistical Data on 21st January 2008, 16hrs (data refreshed every four hours) (CROSKI, 2008)

Year	1997	2004	2005	2006	2007	Overall Total (1996-2007)
Books	303	600	584	481	220	5134
Book chapters	632	1397	1179	967	538	11650
Textbooks and Scripts	137	271	175	194	112	2252
Scientific papers in CC Journals	888	1558	1661	1627	1216	16726
Professional and other papers in CC journals	77	121	134	107	42	955
Articles in a journal stated in NN 2/97	717	0	0	0	0	5867
Papers in other journals	2294	4331	4071	3145	1599	37067
Conference report in CC journals	22	151	204	114	1	1038
Papers in the publishing process	0	150	334	642	846	1976
Invited lectures	392	1046	1088	1002	606	8140
Conference papers with international peer-review	1157	2251	2227	1930	1380	21196
Other conference papers	669	1141	1308	922	534	11868
Abstracts in Book of Abstracts and unpublished papers	1612	3400	3449	3166	1900	29039
Dissertations, master thesis	418	773	820	594	253	7079
Graduation thesis	817	1487	1443	1336	637	12687
Other papers	625	1254	1838	896	495	11636
Patents	30	48	18	16	9	389
Overall Total	10790	19979	20533	17139	10388	184699

¹¹ The Dublin Core metadata element set is a standard (NISO Standard Z39.85-2001) for cross-domain information resource description.

The distribution of the bibliography by scientific field shows that most works are published in Natural and Technical sciences.

HRČAK is an on-line portal of scientific journals in Croatia, which promotes the so-called "Open Access" initiative. Established through a cooperative project between the Croatian Information and Documentation society (HID), the SRCE and the library of the Ruđer Bošković Institute, HRČAK encompasses 83 journals and 3,599 full-text articles, covering all fields of science (2006). To its users, HRČAK offers easy access to scientific journals and works, while editors benefit from tools which help them publish their journals in electronic version free of charge. Through the OAI-PMH protocol (Open Archives Initiative Protocol for Metadata Harvesting), HRČAK provides metadata on every newspaper and article created to the Dublin Core standard¹¹ to all interested information servers (HRCAK, 2006).

There are about 100 published papers per one registered patent in Croatia, whereby it is apparent that the private sector is more inclined to registering patents, while the public sector is more successful in publishing scientific and expert papers (Government of the Republic of Croatia, 2006d). However, the Science Citation Index (SCI) places Croatia low on the scale of developed and relatively developed European countries, thus it is important to further increase the quality of scientific work and, particularly, to increase the number of scientific innovations. This would result in the improved relevancy, actuality and openness of research projects in Croatia, as well as improving the quality of the overall research process (Government of the Republic of Croatia, 2003c).

5 National R&D Strategy and Legal Framework

Both innovation policies and entrepreneurship-related policies are key pillars of the European Union's Lisbon Strategy. There is obviously a general understanding of the importance of innovation as a concept among the South Eastern European countries, but the kind of policies required to encourage innovation in a wider policy setting have not yet been properly implemented across the region. The transition to a knowledge-based society requires national strategies to be set up in order to sustain this new concept. Appropriate institutional regimes, skilled and creative human resources, a dynamic information and communication infrastructure and economic incentives, among other things, need to be provided in order to achieve an efficient innovation system (Dall, 2006).

R&D policy development in the Western Balkans region is often intertwined with the European Union accession process, although only Croatia has actually started the negotiation process with the European Union. In order to withstand the competitive pressure of the common market and become a fully fledged knowledge-based economy, it is of vital importance for the country to implement the required policies and strategies (Dall, 2006). As stated in the "Shared Vision" of the Thessaloniki Agenda for the Western Balkans, the citizens will need to exploit their high level of motivation for social mobility and their relatively good educational background, but also combine scientific and technological knowledge with entrepreneurship. In this respect, science, research and technological development are seen as essential tools for future economic stabilisation and growth in the region (CORDIS, 2003).

5.1 Legal Framework for National R&D System

The importance of science and technology is crucial for the development, progress and prosperity of a modern state. As part of the process of creating an effective and contemporary

scientific and technology system, the adoption of a functioning legal framework which effectively regulates the organisation of R&D institutes and the innovation infrastructure, and issues grants to research organisations and innovative companies, is indispensable. Even though the legislation in Western Balkan countries is still largely undergoing a process of transition, it has already profited from the stabilisation and association processes. As a leading country in the Western Balkans region, Croatia started accession negotiations with the European Union in October 2005, recently opening (and closing) the 25th Chapter of the EU's *acquis communautaire* on Science and Research (Dall, 2006).

Table 5.1: Important Laws in the Legal S&T Framework of Croatia (Dall, 2006; Becic and Svarc, 2007)

Law on Scientific Activities and Higher Education	Stipulates the systems of scientific activity: scientific research, development and higher education
Law on the National Foundation for Science, Higher Education and Technology Development of the Republic of Croatia	Regulates the National Foundation for Science, Higher Education and Technology Development (NZZ)
Law on the Croatian Academy of Sciences and Arts	
Law on Croatian State Science Awards	
Laws on IP Protection: Law on Patents, Copyright and Related Rights Law, Trademark Law, Law on Industrial Designs, Law on Indications of Origins of Products and Services, Law on Protection of Topographies of Semiconductor Products	The Croatian Intellectual Property Rights regime was supported by a CARDS project and comprises the Law on Patents and related laws.
Law on the Recognition of Foreign Education Qualifications	It was amended in 2006. The Amendment separated academic and professional recognition of higher education qualification.
Law on Professional and Academic Titles	

Most frequently, laws are prepared separately for the areas of S&T and education. However, in Croatia, the fundamental law in the field of science is the Law on Scientific Activities and Higher Education (see Table 5.1), which was adopted in 2003 as an attempt to harmonise national legislation with EU practices following the merger of the Ministry for Science and Technology and the Ministry of Education. This act stipulates the systems behind scientific research, development and higher education, emphasises the freedom and autonomy of scientific activity and lays out the framework for reforming the S&T system. It paves the way for strengthening university autonomy through the initiation of lump-sum financing, providing the framework for the implementation of the Bologna process (Becic and Svarc, 2007).

Furthermore, it defines research and higher education activities and stipulates the tasks and structure of the National Science Council and the National Council for Higher Education, as well as defining procedures for establishing scientific institutions (in terms of their basic

structures and the registration process), the framework of scientific and technological parks, and a structure for the categorisation of researchers and research assistants. In order to facilitate its implementation, the law was amended in 2004 (Dall, 2006). In 2005, the National Council for Science initiated a project to electronically register Croatian scientists. Since September 2005, the Council has been working intensively to update the application in line with the provisions of the new Law and Regulation (Government of the Republic of Croatia, 2006c).

Intensive reform of the Croatian higher education system commenced in 2003 with intensive legislative and institutional preparation, and continued in 2004 with the adoption of necessary amendments to the Law on Scientific Activity and Higher Education, and the adoption of a new Law on the Recognition of Foreign Educational Qualifications. In 2005, the Government adopted five Rules of Procedures covering the field of higher education. The MSES is preparing new amendments to the Law on Scientific Activity and Higher Education and the Law on Professional and Academic Titles (Government of the Republic of Croatia, 2006c).

Other important laws and subordinate legislation include the Law on the Croatian Academy of Arts and Sciences, the Law on Croatian State Science Awards, the Law on the National Foundation of Science, Higher Education and Technology Development, as well as several specialised ordinances, decisions and regulations, such as the Law on Geological Research and the Ordinance on the Conditions and Manner for Taking the Examination of Independent Geological Research and Contents of the Examination. Under the responsibility of the MSES, several decisions and guidelines on implementing the Croatian Programme for Innovative Technological Development (HITRA) and the Programme for the Development of Knowledge-Based Companies have also been included in the legal framework for technology and innovation policy (Government of the Republic of Croatia, 2003b).

In the field of telecommunications and information society, the government has amended the Telecommunications Law, adopted the Law on Electronic Identification and the Law on Information Security (all 2005). A number of strategies, recommendations and programmes were adopted for the efficient implementation of R&D policy, which will be discussed in the chapter below (Government of the Republic of Croatia, 2006c).

Intellectual property protection and patenting are regulated by the Patent Law, the Trademarks Law, the Law on Geographical Indications and Designations of the Origin of Products and Services, the Law on the Protection of the Topographies of Semiconductor Products, the Industrial Designs Law and the Copyright and Related Rights Law (all adopted in 2003). There are also several by-laws regulating the implementation of the above mentioned laws. The State Intellectual Property Office (SIPO) is the pivotal institution in the Croatian National Intellectual Property System which also maintains institutional connection with the international intellectual property system (EPO, OHIM, WIPO and WTO), as well as national offices in the Member Countries of the mentioned intergovernmental organisations¹² (Government of the Republic of Croatia, 2005).

The Croatian tax system allows imported scientific research equipment to be exempt from customs duty, and reimburses the value added tax paid for the procurement of scientific research equipment in Croatia and abroad. The broad Investment Funds Law aims to influence the development of venture capital, which is not yet at an advanced stage in Croatia (Dall, 2006).

¹² Please see chapter 4.1 for more information on Croatia's patent activity.

5.2 Main Documents Reflecting National Innovation Strategies

Too often, innovation is a topic subordinated to science or research policy, or even to development policy. Most S&T policies in the Western Balkans region encourage sustainable support for basic research at higher education and research institutions, for the development of human resources and for cooperation in the framework of the European Union's RTD Programmes, joint research programmes with the European Science Foundation and bilateral agreements (Dall, 2006).

The national innovation system (NIS) in Croatia is a complex, but not fully coherent, set of institutions. The most critical components of the Croatian NIS are the absorption capacity and the human capital, especially regarding quality-control management, the number of researchers in industry, the computerisation of the country, the investment in tertiary education and the number of new scientists in engineering. In order to create conditions for the sound development of the innovation system, Croatian policymakers will need to follow the objectives of the Lisbon agenda, which requests a shift from conventional science policy towards an integrated and pro-active innovation policy. In other words, the integration of science, industry and technology policy is needed in order to put scientific potentials into work (Svarc and Becic, 2006).

Table 5.2: Documents Relevant for Innovation Policy in Croatia (Svarc and Becic, 2006)

1996	The National Science and Research Programme
2001	Croatian Programme for Innovative Technological Development (HITRA)
2002	"Croatia Based on Knowledge and Application of Knowledge" adopted by HAZU
2003	Strategy of Development of the Republic of Croatia in the 21 Century - Science
2004	Strategic Plan of the National Foundation for Science 2004-2008
2005	A national Strategy for Development of the Intellectual Property System
2005	Education Sector Development Plan 2005-2010
2004	55 Recommendations of The National Competitiveness Council for Increased Competitiveness in Croatia
2006	Science & Technology Policy of the Republic of Croatia 2006-2010 adopted by the Government of the Republic of Croatia
2006	Strategic Development Framework for 2006-2013, adopted by the Government of the Republic of Croatia
2007	Action Plan of Science & Technology Policy of the Republic of Croatia accepted by World Bank and Government of the Republic of Croatia

The basis of the Croatian innovation system was laid out in the first 'National Science and Research Programme' of 1996, with the main objectives being the establishment of institutional technology infrastructure, adoption of adequate measures, and the development of a programme for technological development. However, the turning point in innovation policy development came in early 2001, when programmes to promote cooperation between industry and R&D systems were introduced. The national technology policy is based on the 'Programme for Innovative Technological Development' (HITRA) adopted in 2001 (see paragraph below). In 2003, the government adopted the 'Strategy of Development of Croatia in the 21st Century - Science', which replaced the 'National Scientific Research Programme'

of 1996. In April 2004, a Cooperation Agreement was signed between the Ministry of Science, Education and Sports and the Ministry of Economy, Labour and Entrepreneurship, regarding the harmonisation of education policies with the country's economic needs, and the development of the national innovation system (Uvalic, 2006).

The building of the national network of technological centres will require the establishment of business and innovation centres, centres for technology transfer, financial institutions, institutions for planning and control, innovation and engineering associations and other centres of technological excellence (Government of the Republic of Croatia, 2005).

HITRA, the Croatian Innovation Technology Development Programme was launched in 2001 by the Ministry of Science and Technology, specifically aimed to support the transfer of technology to new technology-based firms using both financial and non-financial incentives. There are three strategic long-term goals of the HITRA program: the creation of incentive policy measures for technology policy, the creation of a technological institutional structure and the establishment of control mechanisms for innovation and technology policy. HITRA is especially targeted at public-private partnerships or science-industry cooperation and provides a framework for direct cooperation between entrepreneurs, industry, Croatian higher education institutions and research institutes. The target groups are individuals, legal entities and technology-based companies, all with commercially and technically viable ideas (European Commission, 2004). HITRA is being implemented through two complementary sub-programmes - TEST (Technology Research and Development Projects) and RAZUM (Development of Knowledge-Based Enterprises). TEST is designed to support pre-commercial research activities in the development of new products, processes and services, until the design phase is complete (CIT, 2006). It is targeted at academia and research institutions, and provides financial support to the development of new technologies, as well as complex projects for technological development such as prototype, pilot solution, accredited laboratories and intellectual products. Projects related to industry application are encouraged, as well as those leading to new approaches in fundamental and applied research. Its main objective is to achieve cooperation between the research and economic sectors. Besides Technology Projects, further sub-categories of this programme are Complex Technology Projects (STIRP) that are focused on multidisciplinary, pre-commercial and cooperative research, and JEZGRA Projects, which are aimed at creating centres of excellence in research and technology, based on public-private partnerships. EUR 2.8 million has been secured in the state budget for 2006, for implementation of this programme (Government of the Republic of Croatia, 2006d). Implementation of TEST has been entrusted to the Croatian Institute of Technology (CIT), established in March 2006 under the authority of the Government of the Republic of Croatia. Since the establishment of HITRA, 482 projects have been submitted to TEST, 252 of which received positive evaluation and financial support. To this date, 150 projects have been completed, while 102 are still being financed (CIT, 2006).

RAZUM is an Innovation Commercialisation Programme and is designed to support entrepreneurial projects based on new technologies and higher value-added products (Government of the Republic of Croatia, 2005). The Business and Innovation Centre of Croatia (BICRO) is implementing the RAZUM sub-programme. The most important features of this service are the high professionalism of implementation, the absence of administrative constraints on decision-making, as well as the development of specific knowledge and a network of experts for financing, assessing and managing entrepreneurial projects. Until 2004, BICRO has analysed 70 entrepreneurial projects, 15 of which received financial support (European Commission, 2004). The programme operates based on public support and other sources of financing (such as the Croatian Bank for Reconstruction and Development (HBOR), the Ministry of the Economy, Labour and Entrepreneurship (MELE), the Fund for Development

and Employment (FDE), and a World Bank loan), contributing 70% of project costs in the form of conditional grants, and the remaining 30% is contributed by the private sector (Government of the Republic of Croatia, 2006d).

Overall monitoring of the performance of HITRA is organised through the submission of annual reports to the MSES and the government. The budget for HITRA has been steadily increasing, from EUR 7.2 million in 2001, to EUR 11.7 million in 2003 (European Commission, 2004).

The introduction of these programmes was a step to modernise the approach to innovation policy in terms of the "Triple Helix" model. This model consists of three basic actors with intertwined actions - the government, higher education institutions and businesses - working to shorten the time-span between discovery and utilisation. However, the programmes did not manage to strengthen all elements of the model; in particular they failed to promote links between R&D and business to the expected degree. The main reason is found in a weak industrial R&D sector and a low level of technological capability in the business sector. The implementation of HITRA and its contribution to the development of the Croatian NIS has so far been insufficient and requires further improvements (Aralica and Bacic, 2005).

To enable the right technology infrastructure to support commercialization of research outputs and development and growth of knowledge-based enterprises, the Government has initiated, with support from the World Bank, the Technology Infrastructure Development Programme (TehCro), administered by BICRO, which will grant support for creation of technology incubators, R&D centres and technology-business centres linked to research/academic institutions and R&D-based industry. The Government shall commit EUR 6.5 million to the programme, and Croatian financial institutions, like HBOR - Croatian Bank for Reconstruction and Development are expected to contribute around EUR 2 million (Government of the Republic of Croatia, 2006d).

The Research and Development Programme (IRCro), administered by BICRO, is intended to encourage and stimulate demand for services of public research institutions, as well as to encourage SMEs to invest in R&D activities. The Programme envisages utilization of extensive facilities available within the universities and research institutions in the country. Projects under the IRCro Programme involve cooperation between an industrial firm and research/academic institutions and are jointly funded by the IRCro programme and the industrial company involving a 50/50 matching grant scheme. Thus, the private sector participates 50% in funding of R&D activities. A total of EUR 1.5 million has been secured in the state budget up until the end of 2009 for this programme (Government of the Republic of Croatia, 2006d).

Research projects and programmes in Croatia are evaluated by one of 45 peer review groups, and each project proposal is evaluated by a group of nominated evaluators. Projects are contracted for a period of three to five years and principal researchers are required to submit a report of their research once a year. Based on the evaluation of the report, the ministry decides whether to continue financing the project. Following the completion of the project, a final report is submitted and is evaluated by its respective peer review group. Projects are classified according to the field of science, and priorities are set within each area (Uvalic, 2006).

Experts from the Institute of Economics in Zagreb have published an in-depth study evaluating Croatia's innovative capability using the framework of the European Innovation Scoreboard (EIS). According to their findings, Croatia ranks well in comparison to other countries of Central and Eastern Europe, but has not made significant progress in its innovation potential

and policy with respect to the European Union. Innovation policy in Croatia has so far been developing under the umbrella of R&D policy, resulting in the relative neglect of innovation policy's potential to contribute to higher economic growth - it is only in the last few years that the first elements of innovation policy, in the form of technological programmes, have appeared. The significance of innovation policy for the economy has traditionally been better recognised in advanced economies, which have promoted it as the main strategic tool for achieving competitiveness in industry, paving the way to the knowledge-based society. Some indicators of Croatia's human resource potential (for example, the share of science and engineering graduates) offer encouraging results, while others (for example, life-long learning) are totally neglected. While the high-tech service sector in Croatia appears relatively developed, the high-tech manufacturing sector is clearly underdeveloped. Furthermore, policies have mostly failed to create both public and business knowledge - expenditures on R&D while patenting applications made by Croatian residents to the EPO are the lowest among countries of Central and Eastern Europe (Aralica and Bacic, 2005). The key problems contributing to Croatia's low innovation capacity can be found in the low demand for innovation and technologies, the low investment rates in R&D by the business sector, the poor orientation of R&D towards the business sector, the undeveloped system of technology transfer and undeveloped statistical system, all of which are inappropriate for a knowledge-based society (Government of the Republic of Croatia, 2005).

The European Union has eased this transition process by establishing a European Area of Research and Innovation, in an attempt to encourage key interfaces in innovation networks; namely between companies and financial markets, R&D and training institutions, advisory services and technological markets (Aralica and Bacic, 2005).

The Croatian government has put the establishment of a modern innovation system among its microeconomic and structural priorities, defining its goal as a system that encourages cooperation among the education and science systems, government institutions and private enterprises, in order to achieve successful technological development. On the national level, a politically independent advisory body - the National Competitiveness Council (NCC) - put the development of innovativeness and technology as one of the top political and economic priorities. The results of the council's work are embodied in a document entitled '55 Recommendations for Improving Croatia's Competitiveness'. The council outlined several principles to help the country attain a modern approach to innovation policy which will strengthen the components of innovation capability (absorptive capacity, demand, innovation diffusion and R&D), lead to productivity growth and strengthen the knowledge component behind new investments (Aralica and Bacic, 2005). The general objectives of R&D policies are to restructure the scientific research sector, increase investment in science in order to reach 3% of GDP, financially diversify (increase private sector finance), utilise regional research methods and achieve optimal scientific research through international cooperation.

Regarding the development of an information society, the government of the Republic of Croatia adopted a strategic document in 2002 entitled 'Information and communication technology - Croatia in the 21st century'. The document encompasses seventeen recommendations for Information and Communication Technology-related activities (MSES, 2006b). During 2006, the government was working intensively on the preparation of the 'Strategy of Broadband Internet Access Development and Strategy of Telecommunication Development in Croatia' (Government of the Republic of Croatia, 2006b). The government should continue to implement its new strategy of broadband development which has set the goal to achieve 500,000 broadband subscribers by the year 2008 and mobilize all necessary support towards meeting this important target (SBRA-Great-IST, 2007). In 2005, the 'National Programme on Information Security in Croatia' was adopted, following the adoption of the 'Declaration of

Principles and Action Plan' (World Summit on Information Society, 2003). Furthermore, the government adopted an 'Operative Action Plan 2005-2008' for the successful implementation of the National Programme on Information Security (Government of the Republic of Croatia, 2006b).

Dynamic governmental activity was also present in the education sector. The MSES adopted an 'Education Sector Development Plan 2005-2010' and a number of support programmes in order to ensure the efficient implementation of the plan, with the assistance of the International Bank for Reconstruction and Development (IBRD). The programme design is built upon four broad pillars that form the basis of the sector reform priorities: Creating Learning Schools, Improving Management and Leadership, Strengthening Monitoring and Evaluation, and Supporting Regional Development and Innovations. Taking account of the current situation, in terms of the process of globalisation and stabilisation, economic restructuring and the pressures of competition, demographic factors, as well as the need for modernisation and the development of a knowledge-based society and economy in Croatia, there is a clear need for effective changes in the development of the education system. To ensure continuity, new educational policies rely on preserving the fundamental values of Croatian society, while also utilising new guidelines and activities in order to develop the Croatian educational system in line with the state-of-the-art standards of Europe and the rest of the world (MSES, 2005a).

The State Intellectual Property Office of the Republic of Croatia (SIPO) drafted a 'National Strategy for the Development of the Intellectual Property System of the Republic of Croatia 2005-2010', which was adopted by the government in October 2005. By adopting this strategy, the government secured fundamental conditions regarding the level of intellectual property protection, similar to those implemented by the European Union. The strategy should create the grounds for further implementation and development of intellectual property, as one of the key factors of the overall economic, social, cultural and scientific development of the country (SIPO, 2006).

On 5th May 2006 the Government of the Republic of Croatia adopted a document 'Science and Technology Policy of the Republic of Croatia 2006-2010'. This strategic document presents a vision of the development of the Science and Technology sector in the Republic of Croatia. The main goals of the Science and Technology policy are increased investment into science, research and development based on the principle of excellence, their greater impact, realignment of the science sector, fostering of scientific partnerships and the support system for outstanding young researchers, support and strong connection of science and industry, establishment of a motivating framework for their joint development, support of all measures leading to development of technology and innovations, with a more intensive participation of Croatian scientists in the European Union Framework Programmes (Government of the Republic of Croatia, 2006d).

The key objectives presented in the S&T Policy are (Government of the Republic of Croatia, 2006d):

- To increase funding for excellent science and technology projects,
- To restructure publicly-funded research institutes and R&D centres,
- To encourage research partnerships and strengthen support schemes for quality young researchers,
- To invest in science research infrastructure and knowledge transfer institutions,
- To introduce measures to promote commercialisation of academic research,
- To introduce measures to promote technological development and innovation,
- To administer stimulating and business-friendly legislation.

5.3 Main Fields of Intervention and Research Priorities

Innovation policy as such has only recently re-emerged in the Western Balkan countries, after having been reduced to a secondary role during the transition process. According to Radosevic, innovation policies in the region should recognise the structural weaknesses of their individual innovation systems and apply country-specific solutions, as opposed to the rather imitative mode that has so far prevailed (Radosevic, 2005). Investment in R&D and high-tech orientation are regarded as the dominant paradigm in innovation policy (Dall, 2006).

Serious long-term structural problems that affect the S&T sector need to be solved in order to assure further development. Amongst these structural problems are budgetary constraints and public debt, a generally low level of development, the need for industrial restructuring, widespread unemployment and massive migrations, pointing to the need for industrial restructuring in largely de-industrialised economies (Uvalic, 2005). Due to the overall lack of resources, prioritisation is of utmost importance and research orientation needs to be steered towards the economic and social needs of the present in order to make provision for the future. International programmes need to use foresight and support the process of prioritisation, as simply focusing on the RTD Framework Programme or imitating the strategies of other countries will not bring about the desired results (Uvalic, 2006).

Priority setting in S&T is intended to facilitate the efficient performance of certain identified S&T fields, by providing a predictable allocation of critical-size funds. The need to define thematic S&T disciplines and fields has been generally recognised across the region, especially in Croatia (Uvalic, 2006). The government of the Republic of Croatia has laid out strategic priorities for RTD funding in the upcoming period - amongst key priorities are the reform of the higher education system, brain-gain, Information and Communication Technology, Biotechnology, new materials and new production processes, Environmental Sciences and sustainable development, and the socio-cultural transition from an industrial- to a knowledge-based society etc. In the process, Croatia will surely benefit from the European funds which have become available since the start of the EU negotiation process.

The vision of the Croatian R&D programme is to develop a high quality S&T and higher education sector that would support economic, social and humane progress and, through its contribution, would serve as a backbone for the development of a knowledge-based society. The excellence of the R&D sector should be proven through innovativeness, originality, effectiveness, increase in the number and quality of patents, publication of top-level scientific papers and above all, through rationality, adaptability and the ability to transfer knowledge into the economy, as well as through cooperation with higher education institutions, research institutes and the industry (Government of the Republic of Croatia, 2006d).

The majority of financed projects demonstrate that researchers and institutes are interested in specific topics (curiosity-driven research). The overall distribution of funds reveals that the majority of research in Croatia falls within the Biomedical, Technical and Natural sciences. As mentioned above, most research activity is conducted at higher education institutions and public institutes. The substantive part of budget resources for R&D is distributed through the MSES programme, 'Research Projects', and is intended for all fields of science regardless of the thematic area and type of research. However, the budget is designed to assure the balanced development of the six main fields of science usually serviced by the MSES in terms of the planning, monitoring and evaluation of research activities. According to the MSES, 1,295 research projects covering all scientific areas were financed in 2002 and 1,760 were financed in 2005. The distribution by scientific fields in 2005 was the following (Becic and Svarc, 2008):

- natural sciences (24.5%)
- technical sciences (18.1%)
- bio-medical sciences (28.1%)
- bio-technical sciences (9.7%)
- social sciences (9.6%)
- humanities (10.0%).

With regard to socio-economic objectives, the largest share of research in the higher education and government sector is devoted to “non-oriented research”, followed by “social structures and relationships” and “protection and improvement of human health”. In the business sector, the majority of research is aimed at “industrial production and technology”, “agricultural production and technology” and “protection and improvement of human health (see Table 5.3) (Becic and Svarc, 2008).

Table 5.3: Domestic R&D expenditure by sectors and socio-economic objectives, Croatia, 2005 (Becic and Svarc, 2008)

	All sectors	Business sector	Government	Higher education	Non-profit
Exploration and exploitation of the space	0.02	0	0	0.7	0
Non-oriented research	28.75	9.34	37.44	37.28	0
Other civil research	2.74	1.75	2.92	3.81	0
Defence	0	0	0	0	0
Exploration and exploitation of the Earth	4.42	0.32	12.32	3.84	0
Infrastructure and general planning land use	0.5	0.23	0.41	0.9	0
Control and care of the environment	2.74	1.35	5.31	2.63	0
Protection and improvement of human health	15.95	22.27	11.21	11.71	13.48
Production, distribution and rational utilisation of energy	2.25	1.63	3.72	1.97	0
Agricultural production and technology	16.72	24.17	7.37	14.41	0
Industrial production and technology	19.02	38.91	0	8.6	0
Social structures and relationships	9.88	0.02	19.3	14.8	86.52
TOTAL (in %)	100	100	100	100	100

Source: CBS, R&D statistics database.

The Croatian government and governmental bodies have recently been adopting development strategies and implementation policies with an accelerated pace. Achieving EU accession country status and beginning the negotiation process have had a positive impact on Croatia’s development process, while access to EU financial funds and the distribution of know-how have also had a beneficial effect.

In the field of Science and Technology, the MSES started the preparation of a broad-based Technology Programme in October 2002, building on the earlier efforts and successes and prioritising the economy’s needs in a systematic way. This work, supported by the World Bank Technical Assistance Project for Institutional and Regulatory reform for Private Sector Development (TAL-2), resulted in the ‘Science and Technology Project’. The project was created with the objective of securing accession to the European Union, as well as building a dynamic and competitive economy that can rapidly achieve convergence to EU living standards. The project supports Croatian industry through various programmes, including the

modernisation of the S&T system, maintaining high-quality science infrastructure, upgrading the technological capabilities of firms, and developing a means of non-traditional financing, for example, venture capital. The high level of externalities which characterise these activities justifies the public assistance in these areas as firms invest at sub-optimal levels in R&D and once diffused, knowledge can be accessed by anyone as a public good. Increased productivity, an improved technological base, and strengthened links between research and development institutions, the scientific community and industry will help enterprises compete more effectively and facilitate Croatia's economic integration into the global market. The project consists of three main components (MSES, 2006b):

1. Restructuring of Research and Development Institutions (RDIs)
2. Establishing the Business Innovation Centre of Croatia (BICRO)
3. Unity Through Knowledge Fund

The restructuring of R&D institutions aims to strengthen the capacity of selected Croatian R&D institutions and to reorient their research infrastructure to serve the economy. The restructuring of RDIs, including the Brodarski Institute and the Ruđer Bošković Institute, is also supported in order to increase their applied and contractual research capacity, both within Croatia and in international markets. The project finances the purchase of equipment, consulting services and training; furthermore, it envisages support for the establishment of Science Parks (MSES, 2006b).

BICRO aims to upgrade technological capabilities of enterprises, to finance technology development programmes (e.g. RAZUM Programme), to promote Venture Capital in Croatia, to develop technology centres, incubators and R&D centres, and to establish a Sponsored Research and Development Programme (to provide grants to finance SME research projects).

The Unity Through Knowledge Fund (UKF), as described above, is a facility aimed at attracting the Croatian Diaspora, specifically scientists and researchers living abroad. The UKF supports the following activities: motivating expatriate Croatians to do scientific research, setting up a network of Croatian Scientific Diaspora and financing short-term visits of eminent Croatian expatriates to Croatia, attracting expatriate Croatians to launch start-up companies and other related initiatives in line with the project motto Connectivity - Cooperability - Creativity (MSES, 2006b).

The report of the Great-IST project (FP6) has stated some weaknesses and threats for Croatia, especially focussing on the domain of Information and Communication Technologies (SBRA-Great-IST, 2007): weak cooperation between ICT SMEs and research organisations; poor awareness of joint initiatives between ICT companies and research organizations; the level of innovativeness is ten times lower than in EU countries; insufficient following of EU trends in innovation and creativity; low support to the creation of centres of excellence in research and technology, based on public private partnerships.

On the other hand, some strengths and opportunities should not be neglected: high growth rate of the IT market; the telecommunication infrastructure is the most modern in the SEE region with 100% digitalized network; Croatia is a leader in the region according to the level of implementation and commercialisation of new technologies; relatively high efficiency and productivity of Croatian workforce; participation in FP6 has been rather successful, and in the IST area Croatia scored highest among the 20 target countries; implementing a new strategy of internet broadband development which has set the goal to achieve 500,000 broadband subscribers till the year 2008; harmonisation with the EU, prospect of joining the Union in the not too distant future (SBRA-Great-IST, 2007).

6 Summary and Draft Conclusion

In today's globalised world economy, enhanced by the constant pressures of competition markets, economic restructuring in transition countries is unavoidable. The transition towards a knowledge-based society is perceived as a way of keeping pace with the EU's global competitors. Unfortunately, countries of the Western Balkans region mainly disregarded the role of R&D systems and innovation activities during the 1990s, with public innovation policies only emerging at the end of the 1990s. Growth and innovation in the economy are globally recognised to be dependent on R&D, on the capability to absorb and diffuse technology and on the demand for its generalisation and utilisation. In Croatia, innovation policy has been marginalised, mostly due to the shifting of priorities towards macroeconomic policy and obsolete understanding of innovation policy in general. In order to improve such conditions, the ministry should adopt adequate measures to re-establish the vast national R&D base, educational system and the business sector. Knowledge will have to be applied and used commercially, as opposed to the current situation, where there is no incentive to turn to the market. Such a transformed market-oriented research and education system will be forced to monitor signals from the marketplace and improve its capacity to supply innovation. However, experts have warned about the possible outcomes of such shock-therapy, which could leave the national university and research system entirely dependent on the market. Such a turn would probably result in a shift from one extreme to another - from an emphasis on fundamental research to an emphasis on applied research (Aralica and Bacic, 2005).

Notwithstanding the devastating effects of war between 1991 and 1995, Croatia has managed to maintain the activities of all higher education institutions and scientific institutes, as well as its involvement in regional and international projects. Following its political efforts in gaining candidate country status to the EU accession process, Croatia has been adopting reforms with an accelerated pace. Research and development in Croatia is well integrated in the world R&D system and about 30% of its potential was oriented to international research projects. Substantial efforts were invested in formulating scientific and technological policies and commencing their implementation process. Reforms in the science and research sector include substantial institutional and legislative reform, emphasising the importance of creating synergy between science and economic development. Further incentives were provided by introducing new technologies, creating new knowledge, developing new products and services etc. The government has clearly expressed its determination to implement further policies which support and encourage the development of the RTD sector, since research, technology and development are perceived to be the driving forces behind employment, economic development and overall competitiveness of a state. Since 2003, Croatian science policy has been based on the concepts of the Strategy of Development of the Republic of Croatia in the 21st Century - Science, and the Science and Education Act. The overall goals of Croatian RTD are as follows: restructuring the scientific research sector, increasing investment in science (in order to achieve the goals adopted in the Lisbon Agenda - 3% of GDP allocated to science and research), financial diversification (i.e. more intensive integration of the economic and private sectors into financing science), regional diversification of research activity and optimal use of scientific research through international cooperation. The main targets of technology policy include the revitalisation of industrial research, the commercial use of scientific research, building-up technology capabilities of companies and developing private incentives for financial investments into technology-based entrepreneurship (European Commission, 2004).

Innovation and higher education indicators represent another aspect of Croatian R&D policy which requires further improvement, especially in terms of their construction and their inclusion in relevant European databases. Although participation in Eurostat significantly

improved during 2005, it is still confined to basic indicators. Sophisticated data, especially that relevant to technological performance, such as patent activity (EPO), high-tech exports, ICT expenditures, etc. are still missing.

According to Becic and Svarc, the status of R&D and innovation indicators reflects, in essence, the old paradigm of economic growth concentrated on labour- and capital-intensive sectors and production/service sectors with low R&D and innovation consumption (Becic and Svarc, 2006). However, the main boost towards the formation of a knowledge-driven economy and the modernisation of the S&T system in Croatia comes from Croatia's accession negotiations with the European Union. With candidate country status, the Lisbon goals were brought into Croatian national development plans, promoting research and innovation as the important drivers of development. Nowadays, it is commonly accepted that there is an urgent need for Croatia to integrate into global economic processes, primarily into the European Union. The role of science, technology and education is perceived as an important factor for European integration and for the transition from an industrial- to knowledge-based economy. The best illustration of this new orientation is the new Science and Technology Policy of the Republic of Croatia 2006-2010 accepted by the Croatian government in June 2006. The main challenge for science policy is to increase the funding for S&T in order to meet the "3% of GDP for research investment" as laid out in the Lisbon Strategy. The priority is to promote economic growth and job creation through research and innovation. Therefore, the key objectives for the science and innovation policy in the near future are as follows: to focus publicly-funded research projects on national priority areas and industrial needs, to encourage research partnerships, mobility and cross-sector cooperation, as well as to introduce new measures to promote the commercialisation of academic research.

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8 List of Acronyms

ALLEA	All-European Academies
AZVO	Agency for Science and Higher Education
BERD	Business Sector Expenditure on R&D
BICRO	Business and Innovation Centre of Croatia
CARDS	Community Assistance for Reconstruction, Development and Stabilisation
CARNet	Croatian Academic and Research Network
CBS	Central Bureau of Statistics of Croatia
CEEOL	Central and Eastern European Online Library
CEI	Central European Initiative
CIT	Croatian Institute of Technology
COST	Cooperation in Science and Technology
CROSBİ	Croatian Scientific References
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organisation
CTT	Centre for Technology Transfer
DFG	Deutsche Forschungsgemeinschaft
EC	European Commission
EERO	European Environmental Research Organisation
EGEE	Enabling Grids for E-science
EICC	Euro Info Correspondence Centre (Zagreb)
EIS	European Innovation Scoreboard
EIT	European Institute of Technology
EMBO	European Molecular Biology Organisation
EPC	European Patent Convention
EPO	European Patent Office
ERA	European Research Area
ERA-NET	European Research Area Network
ESF	European Science Foundation
EUREKA	Pan-European Network for market-oriented, industrial R&D
EUROCORES	European Science Foundation Collaborative Research Programmes
EURODOC	European Council of Doctoral Candidates and Junior Researchers
EQUIBELT	Education Quality Improvement by E-Learning Technology
FP5, FP6, FP7	European Community Framework Programmes RTD
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GÉANT	Multi-Gigabit Pan-European Data Communications Network
GERD	General Expenditure on R&D
GOVERD	Government Sector Expenditure on R&D
GVA	Gross Value Added
HAZU	Croatian Academy of Sciences and Arts
HC	Headcount Equivalent
HE	Higher Education
HERD	Higher Education Sector Expenditure on R&D
HID	Croatian Information and Documentation Society
HIDD	Croatian Information and Documentation Society
HIT	Croatian Institute of Technology
HITRA	Croatian Innovation Technology Development Programme
HRČAK	On-line Portal of Scientific Journals in Croatia
IAEA	International Atomic Energy Agency
IAMP	Inter-Academy Medical Panel
IAP	Inter-Academy Panel
IBRD	International Bank for Reconstruction and Development
ICSU	International Council for Science
ICT	Information and Communication Technology
ICTY	UN International Criminal Tribunal for the former Yugoslavia
IGK	Internationale Graduiertenkollegs
IPA	Instrument for Pre-Accession Assistance
ISOTEIA	Integrated System for the promotion of Territorial-Environmental Impact Assessment

ISPA	Instrument for Structural Policies for Pre-Accession
IUPAC	International Union of Pure and Applied Chemistry
MLAZ	Young Scientists Network of Croatia
MSES	Ministry for Science, Education and Sports of Croatia
NCC	National Competitiveness Council of Croatia
NCP	National Contact Point
NIS	National Innovation System
NISKA	National Information System in Croatian Libraries
NRDP	National R&D Programmes
NFS	National Foundation for Science, Higher Education and Technological Development of Croatia
OAI-PMH	Open Archives Initiative Protocol for Metadata Harvesting
PCT	Patent Cooperation Treaty
PHARE	Poland and Hungary: Assistance for Restructuring their Economies
R&D	Research and Development
RDI	Research and Development Institutions
RTD	Research and Technological Development
RSE	Researchers, Scientists and Engineers
SAA	Stabilisation and Association Agreement
SAP	Stabilisation and Association Process
SAPARD	Special Accession Programme for Agriculture and Rural Development
SCI	Science Citation Index
S&E	Science and Engineering
SEE	South Eastern Europe
SEE-ERA.NET	FP6 project "Southeast European Era-Net"
SEEFIRE	Southeast Europe Fibre Infrastructure for Research and Education
SEE-GRID	South Eastern European Grid-enabled e-Infrastructure Development
SEEREN	South Eastern European Research & Education Network
SFB	Sonderforschungsbereiche
SFRY	Socialist Federal Republic of Yugoslavia
SIPO	State Intellectual Property Office of Croatia
SIS	Scientific Information System of Croatia
SMEs	Small and Medium Size Enterprises
SRCE	University Computing Centre (Zagreb)
S&R	Science and Research
S&T	Science and Technology
STI	Science, Technology and Innovation
STIRP	Complex Technology Projects (Složeni tehnnologijski projekti)
TAL	World Bank's Technical Assistance Project for Institutional and Regulatory Reform
TEMPUS	Trans-European Mobility Scheme for University Studies
TERENA	Trans European Research and Education Network Association
TRIPS	Trade-Related Aspects of Intellectual Property Rights Agreement
UAI	Union-Académique Internationale
UKF	Unity Through Knowledge Fund
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
USPTO	United States Patent and Trademark Office
WAYS	World Academy of Young Scientists
WIPO	World Intellectual Property Organisation
WB	Western Balkans
WBC	Western Balkan countries
WMO	World Meteorological Organisation
WTO	World Trade Organisation
ZSI	Zentrum für Soziale Innovation (Centre for Social Innovation, Austria)

Annex I - Main Institutions in Croatia

Quoted from *Government of the Republic of Croatia (2006c): Science and Technology Policy of the Republic of Croatia 2006-2010*. Available from: <http://public.mzos.hr/lgs.axd?t=16&id=11958>, accessed 15.02.2007.

State Institutions and Bodies

Agency for Science and Higher Education <http://www.azvo.hr>
Meteorological and Hydrological Service <http://www.dhmz.htnet.hr>
State Intellectual Property Office <http://www.dziv.hr>
State Office for Metrology <http://www.dzm.hr>
Central Bureau of Statistics <http://www.dzs.hr>
Croatian Academic and Research Network - CARNet <http://www.carnet.hr>
Croatian Accreditation Agency <http://www.akreditacija.hr>
Croatian Institute of Technology - HIT, Ltd. <http://www.hitech.hr>
Croatian Parliament - Committee for Education, Science and Culture <http://www.sabor.hr>
Croatian Standards Institute <http://www.hzn.hr>
Ministry of Science, Education and Sports <http://www.mzos.hr>
National Foundation for Science, Higher Education and Technological Development <http://www.nzz.hr>
National Council for Information Society
National Council for Higher Education <http://www.azvo.hr>
National Science Council <http://www.nvz.hr>
Business Innovation Center of Croatia - BICRO, Ltd. <http://www.bicro.hr>

Important Scientific Organizations

Croatian Academy of Sciences and Arts* <http://www.hazu.hr>
Academy of Medical Sciences of Croatia <http://www.amzh.hr>
Croatian Academy of Engineering <http://www.hatz.hr>
"Miroslav Krleža" Lexicographical Institute* <http://www.lzmk.hr>

**Institutions of special interest for the Republic of Croatia*

Public Institutes

Institute of Economics <http://www.eizg.hr>
Croatian Geological Survey <http://www.hgi-cgs.hr>
Croatian Institute for Bridge and Structural Engineering <http://www.himk.hr>
Croatian Historical Institute <http://www.isp.hr>
Croatian Veterinary Institute <http://www.veinst.hr>
Institute for Anthropological Research <http://www.pub.srce.hr/antro/hrv/naslov>
Institute of Archeology <http://public.carnet.hr/iarh/>
Institute for Social Research <http://www.idi.hr>
Institute of Social Sciences "Ivo Pilar" <http://www.pilar.hr>
Institute of Ethnology and Folklore Research <http://www.ief.hr>
Institute of Philosophy <http://www.ifzg.hr>
Institute of Physics <http://www.ifs.hr>
Institute of Croatian Language and Linguistics <http://www.ihjj.hr>
Institute of Public Finance <http://www.ijf.hr>
Institute for Adriatic Crops and Karst Reclamation <http://www.krs.hr>
Institute for Medical Research and Occupational Health <http://www.imi.hr>
Institute for International Relations <http://www.imo.hr>
Institute for Migration and Ethnic Studies <http://www.imin.hr>
Institute of Oceanography and Fisheries <http://www.izor.hr>
Institute of Art History <http://www.hart.hr>
Ruđer Bošković Institute <http://www.irb.hr>
Institute for Tourism <http://www.iztg.hr>

Institute for Tourism <http://www.iztzg.hr>
Institute for Agriculture and Tourism <http://www.iptpo.hr>
Agricultural Institute Osijek <http://www.poljinos.hr>
Old Church Slavonic Institute <http://public.carnet.hr/staroslavenski-institut/>
Forest Research Institute <http://www.jaska.sumins.hr>

Private Scientific Institutions

Bc Institute for Breeding and Production of Field Crops* <http://www.bc-institut.hr/>
Brodarski Institute, Ltd. <http://www.hrbi.hr/>
Tobacco Institute Zagreb*
Energy Institute Hrvoje Požar <http://www.eihp.hr/>
Ericsson Nikola Tesla* <http://www.ericsson.com/>
GlaxoSmithKline Research Center Zagreb, Ltd. <http://www.pliva.com>
INA* <http://www.ina.hr>
Civil Engineering Institute of Croatia* <http://www.igh.hr/>
Energy Institute* <http://www.ie-zagreb.hr/>
I3 Information Innovation Institute <http://www.svetikriz.com>
Končar - Electrotechnical Institute* <http://www.koncar-institut.hr/>
Mediterranean Institute Grga Novak <http://www.mign.org>
Mediterranean Institute for Life Sciences <http://www.medils.hr>

**Joint stock company*

Technology and Research and Development Centers

Technology-Development Center Osijek, Ltd. <http://www.tera.hr>
Technology-Innovation Centre of Rijeka, Ltd. <http://www.ticri.hr>
Technology Center in Split, Ltd. <http://www.tcs.hr>
Center of Technology Transfer - Ctt, Ltd. <http://www.ctt.hr>
Research and Development Centre for Mariculture, Ston <http://www.unidu.hr/ric.php>
Center for Karst, Gospić

Universities and Colleges

Universities

University of Dubrovnik <http://www.unidu.hr>
Josip Juraj Strossmayer University of Osijek <http://www.unios.hr>
University of Pula
University of Rijeka <http://www.uniri.hr>
University of Split <http://www.unist.hr>
University of Zadar <http://www.unizd.hr>
University of Zagreb <http://www.unizg.hr>

Public Colleges and Polytechnics

Social Science Polytechnic of Zagreb <http://dns.pravo.hr/veleuciliste/>
"Lavoslav Ružička" Polytechnic of Vukovar <http://www.vevu.hr>
"Marko Marulić" Polytechnic of Knin <http://www.veleknin.hr>
"Nikola Tesla" Polytechnic of Gospić
Polytechnic of Karlovac <http://www.vuka.hr/>
Polytechnic of Požega <http://www.vup.hr>
Polytechnic of Rijeka <http://www.veleri.hr>
Polytechnic of Slavonski Brod
Polytechnic of Šibenik <http://www.vstsi.hr>
College of Electrical Engineering in Varaždin <http://www.vels.hr>
Teachers Education Academy in Čakovec <http://www.vus-ck.hr>

Teachers Education Academy in Petrinja <http://www.vusp.hr>
Police Academy - Zagreb <http://pa.mup.hr>
Agricultural College in Križevci <http://www.vguk.hr>
Technical Polytechnic of Zagreb <http://www.tvz.hr>
Health Polytechnic in Zagreb <http://www.zvu.hr>

Accredited Private Colleges and Polytechnics

American College of Management and Technology in Dubrovnik <http://www.acmt.hr>
International Graduate Business School Zagreb <http://www.igbs.hr>
RRiF Graduate School for Financial Management in Zagreb <http://www.rrif.hr>
"Matija Vlačić Ilirik" Faculty of Theology in Zagreb <http://www.tfmvi.hr>
Polytechnic College Velika Gorica <http://www.vvg.hr>
Business Administration College in Višnjan <http://www.manero.hr>
"Libertas" Academy in Zagreb <http://www.vps-libertas.hr>
"Utilus" Business School, Zagreb <http://www.utilus-zg.com>
"Agora" Academy in Zagreb <http://www.vs-agora.hr>
"Vern" Business School, Zagreb <http://www.vern.hr>
College of Business and Management "Baltazar Adam Krčelić", Zaprešić <http://www.vspu.hr>
Work Safety College in Zagreb <http://www.vss.hr>
Technical College - Polytechnic Studies in Pula <http://www.politehnika-pula.hr>
Evangelical Theological Seminary in Osijek <http://www.evtos.hr>
Zagreb School of Economics and Management <http://www.zsem.hr>
Entrepreneurial Economics College in Zagreb <http://www.zsm.hr>

Computing Centre

University Computing Centre - SRCE, University of Zagreb <http://www.srce.hr>

Web Pages of important Program and Projects of the Ministry of Science, Education and Sports

Scientific projects <http://zprojekti.mzos.hr>
HITRA - Technology projects <http://tprojekti.mzos.hr/>
Croatian Scientific Portal* <http://www.znanstvenici.hr>
Center for on-line databases* <http://www.online-baze.hr>
5. Cooperation with the European Union <http://www.mzos.hr>

**Joint projects of the Ministry of Science, Education and Sports, CARNET and "Ruđer Bošković" Institute*